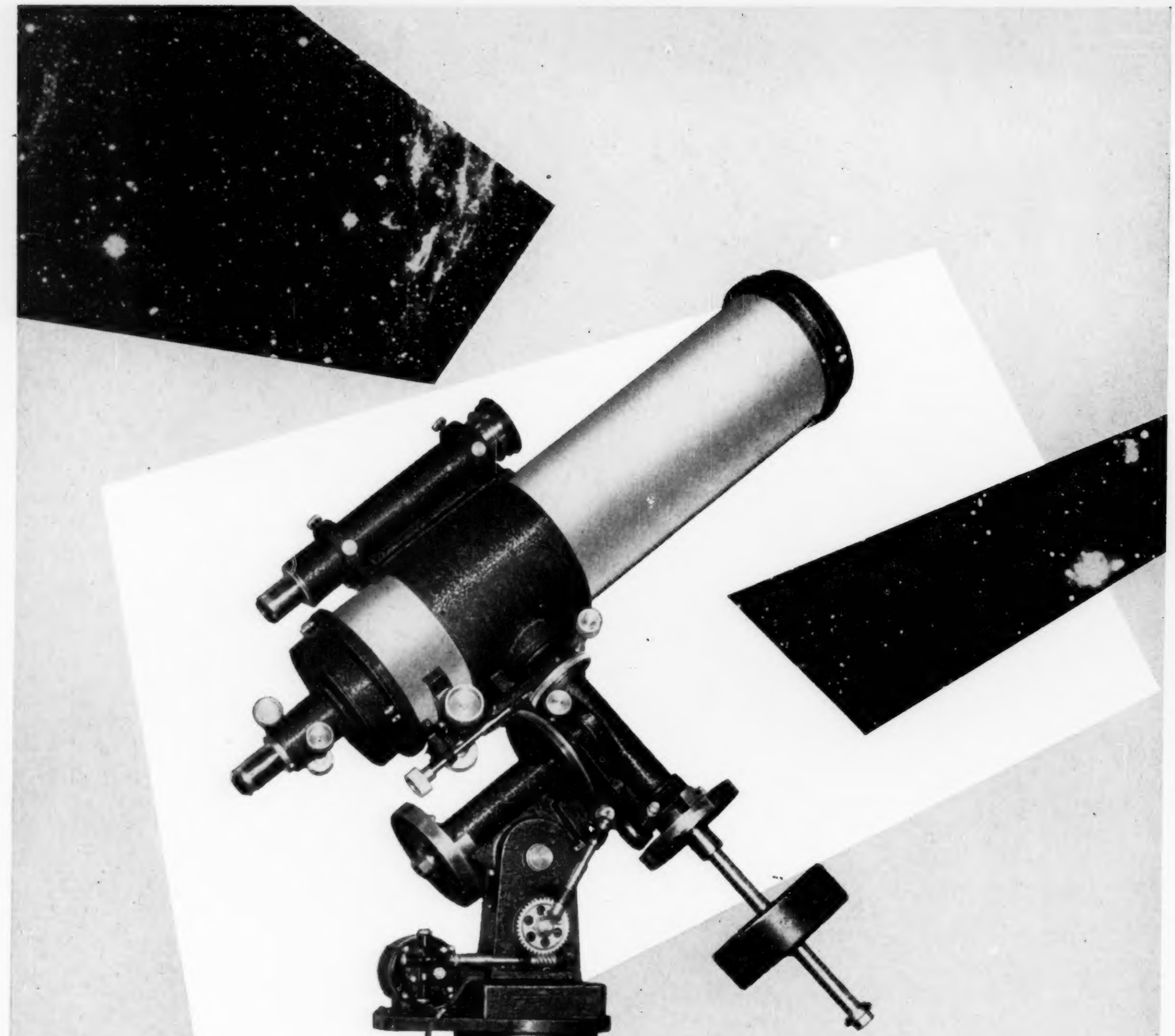
Special Supplement

SMITHSONIAN ASTROPHYSICAL OBSERVATORY

BULLETIN NO. 2

# FOR VISUAL OBSERVERS OF SATELLITES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**SKY and TELESCOPE**

CHARLES A. FEDERER, JR., *Editor*
JOSEPH ASHBROOK, *Technical Editor*





Vol. XV, No. 12 OCTOBER, 1956

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**COVER:** On August 11th, Governor Joseph B. Johnson of Vermont attended the annual convention of telescope makers at Springfield, Vt. He is seen here discussing satellite observing and instrumentation with Dr. James G. Baker, Harvard Observatory (left), and Dr. J. Allen Hynek, Smithsonian Astrophysical Observatory (right). Photograph by Robert E. Cox. (See page 532.)

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The principal articles are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

# National Science Foundation Aid to Astronomy

AMONG the 289 research grants awarded by the National Science Foundation during the quarter year that ended June 30, 1956, there are 17 in astronomy, totalling over $140,000. The list of these projects gives a bird's-eye view of trends in astronomical research today:

E. C. Slipher and A. G. Wilson, Lowell Observatory, photographic patrol of Mars; H. L. Giclas, Lowell Observatory, survey of the northern sky for stars having large proper motions; G. H. Herbig, Lick Observatory, spectroscopic studies of T Tauri stars, and attendance at the conference on unstable stars at Burakan Observatory in Armenia; W. O. Roberts, High Altitude Observatory, studies of the effects of solar activity on circulation in the earth's atmosphere; M. A. Tuve, Carnegie Institution of Washington, studies by a committee on radio astronomy.

G. P. Kuiper, Yerkes Observatory, stars and stellar systems; G. Van Biesbroeck, Yerkes Observatory, astrometric investigations; A. P. Linnell, Amherst College, eclipsing binary stars; B. J. Bok, Harvard Observatory, radio astronomy; S. Gaposchkin, Harvard Observatory, southern variable stars; O. Mohler, University of Michigan Observatory, visits to Soviet observatories.

M. H. Cohen, Cornell University, polarization of bursts of 200-megacycle solar radiation; W. J. Miller, S. J., Fordham University, faint variable stars in the Cygnus cloud; B. S. Whitney, University of Oklahoma, periods of eclipsing binary stars; P. van de Kamp, Sproul Observatory, astrometric studies of nearby stars; N. E. Wagman, Allegheny Observatory, spectroscopic binaries; and D. H. McNamara, Brigham Young University, spectrographic studies of peculiar eclipsing binaries.

Since the National Science Foundation began in 1951 its program of supporting basic research in America, it has awarded 2,495 grants, totalling nearly $30,000,000, in fields ranging from anthropology to zoology.

For the fiscal year 1956-57, the NSF has allotted five million dollars—an eighth of its total budget—to astronomy. The largest expenditure will be to erect the national radio observatory at Green Bank, West Virginia. Its 140-foot radio telescope was described in the March issue, page 199, and on page 398 of July.

The sum of $545,000 has been granted for the development of a national observatory that initially will contain 36-inch and 80-inch reflectors (see page 111 of January, 1956). The site tests have been narrowed to four locations in Arizona and one in Monterey County, California.

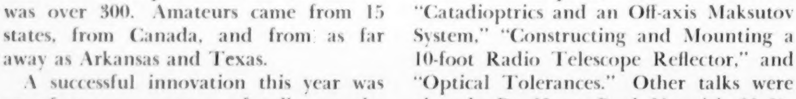

**Returning to the scene of his activities as an amateur telescope maker, Vermont's Governor Joseph B. Johnson talks with James W. Gagan, of the Amateur Telescope Makers of Boston. Stellafane's turret telescope is at the left, and the headquarters building at the right.**

# CONVENTION IN VERMONT

ONE observing instrument was on display for every 10 persons at the telescope makers' annual convention at Stellafane, near Springfield, Vermont, August 11th. There were more than 30 telescopes, and the attendance was over 300. Amateurs came from 15 states, from Canada, and from as far away as Arkansas and Texas.

A successful innovation this year was an afternoon program of talks on the more advanced aspects of telescope making. Among the experts who spoke were Dr. James G. Baker, one of the world's leading optical designers, Dr. Robert Fleischer, Rensselaer Polytechnic Institute, and Alan E. Gee, American Optical Co.

These three speakers discussed, in turn, "Catadioptrics and an Off-axis Maksutov System," "Constructing and Mounting a 10-foot Radio Telescope Reflector," and "Optical Tolerances." Other talks were given by Dr. Henry Paul, Norwich, N. Y., on making Schmidt telescopes; Alan M. Mackintosh, Glen Cove, N. Y., on the Schroader caustic test; and Earle B. Brown, Farrand Optical Co., on principles of optics for amateurs. One of three speakers from the Boston area who concluded the program, James W. Gagan, described the Silvertooth method of figuring a Cassegrainian secondary.



**Awaiting their turns to speak during the afternoon are (left to right) Messrs. Gagan, Mackintosh, Gee, Baker, Fleischer, and Cox, with Stanley Brower as a contributing specialist. Photograph by Robert Dunn.**

At 7:00 p.m., the convention gathered in front of the headquarters building to hear a program on the artificial satellite. An unexpected highlight was the opening speech by the Hon. Joseph B. Johnson, governor of Vermont, who is a former president of the Springfield Telescope Makers, which sponsored the convention jointly with the Amateur Telescope Makers of Boston. Governor Johnson pointed out that he was actually an engineer who had turned to politics, and recalled how he had made his first telescope mirror in the 1920's, under the guidance of Russell W. Porter.

Instruments for tracking artificial satellites were described by Dr. J. A. Hynek, of the Smithsonian Astrophysical Observatory. Then Dr. Baker sketched on the blackboard the Schmidt system that is to be used in the 20-inch tracking cameras. The correcting plate for each of these fast Schmidts will have three components.

The final speaker of the evening was G. R. Wright, of the National Capital Astronomers, who is chairman of the national advisory committee for visual observations of the artificial satellite. Mr. Wright showed models of lens systems that will probably be used by visual observers; one such instrument has a field of 12½ degrees and is made of surplus lenses and other parts costing less than 20 dollars.

John Gregory exhibited his 5-inch Maksutov, which won first prize for observing performance. It is strapped to a 4-inch fork-mounted refractor.

Frank Torney's 8-inch reflector took two awards, first place for mechanical perfection, and second prize for optical quality and observing performance.

An extended question - and - answer period followed these talks, indicating a lively interest in observing the satellite. Then prizes were awarded for the mechanical excellence of telescopes and their mountings. First place went to Frank Torney, Weymouth, Mass., for his 8-inch Newtonian. The second prize was shared by Kenneth Smith, Tilton, N. H., and Joseph Talbot, Stoneham, Mass., while third place was won by H. A. Van Zant, Pennsauken, N. J.

Special awards were made to Margaret A. Frisch, Rochester, N. Y., for the best telescope made and exhibited by a woman; to Ray Reniff, Ashfield, Mass., for his fine sidereal clock with a transparent face; and to Paul Jones, Oreland, Pa., for his display of pictures illustrating the construction of a 12½-inch reflector.

Young Paul Floto admires the open-tube reflector of J. H. Liddell.

Early evening clouds disappeared by 10 o'clock, and the judges examined the telescopes for optical excellence, turning them to various celestial test objects. John Gregory, Norwalk, Conn., won first place with his 5-inch Maksutov telescope, while Mr. Torney's reflector gained second prize. Bruce Woodward, Long Island, N. J., was third in the observing tests. Later in the evening fine views of Mars were had with these and other telescopes.

Amateur interest in Maksutov telescopes was very evident at the convention. During his afternoon talk, Dr. Baker urged that amateurs consider making Maksutov instruments of an off-axis type he has designed for commercial use. This proposal was so well received that steps were taken to organize a "Maksutov club."

All persons interested in obtaining glass and help in design specifications for Maksutov-type telescopes should write to Alan M. Mackintosh, 97 McLoughlin St., Glen Cove, N. Y. The Baker specifications have been made available for distribution by Mr. Mackintosh for amateur noncommercial use only. These designs are of 4-inch and 11-inch unobstructed systems, but they may be scaled to other apertures up to 15 inches. For classical Maksutovs, however, substantial savings might be effected by ordering the glass blanks in quantity. As the molds are usually destroyed after such orders are filled, interested amateurs are urged to write to Mr. Mackintosh before December 1st.

A 4-inch Cassegrainian reflector with a special combination anti-diffraction and secondary-supporting disk at the front of the tube.

# ASTRONOMICAL SCRAPBOOK

## Notes on Comet Hunting

KEPLER once wrote that comets are as numerous in the heavens as fish in the ocean, a conjecture that actually is not too far-fetched numerically. The connection between comets and fish goes further than this, however.

Both fishermen and comet hunters carefully choose their appropriate equipment. Knowing when and where to look for lake trout has its counterpart in knowing the most rewarding parts of the sky and hours of the night for comet searching. Checking to be sure that an inconspicuous glow you have found in the sky is actually a new comet calls for skill of as high an order as landing a large game fish. Finally, the elation of the successful angler is akin to the feelings of the observer whose long months of comet searching are finally rewarded by a success.

In recent times, about half a dozen comets have been discovered in an average year. Some, of course, are found accidentally, by amateurs using binoculars and telescopes or by astronomers taking photographs for other purposes. On such a plate there may be an image looking like a fuzzy caterpillar, the short trail of a comet that has moved during the exposure on the stars. Most of the faintest discoveries are returning periodic comets, observable only because a very large telescope can be turned on a predicted position.

A large proportion of comet discoveries come from systematic searches of the sky by amateur astronomers, for whom this is a rewarding field if modest equipment is used with considerable perseverance. Messier and Olbers in Europe, Brooks, Swift, Barnard, Peltier, and Friend in America are names that became world-famous because of repeated comet discoveries. Who will match the record of Jean Louis Pons, a man not content to be merely the doorkeeper of the Marseilles Observatory but using his spare time to find 33 comets between 1801 and 1827?

Some of the most successful comet hunters have given suggestions from their experience that may help the beginner in planning a systematic search program. Here are no hard and fast rules, but indications of principles.

What equipment is needed for visual search? While practically every type of telescope has at some time caught a comet, systematic work demands considerable light-gathering power, low magnification, and wide field. Leslie Peltier uses a 6-inch f/8 refractor, with a power of 48x. W. F. Denning, in England, employed a 10-inch reflector, usually with a 32x eyepiece that had a 1¼-degree field. With lower powers, Denning wrote, there would be danger of passing by small, faint comets.

Large binoculars are very effective. Antonin Mrkos, in Czechoslovakia, has made a number of discoveries with mounted 25 x 100 binoculars, and the veteran Japanese observer Minoru Honda has scored successes with a 15 x 100 pair.

Even smaller instruments are serviceable, though less efficient. It is said that Charles Messier found most of his comets with a 2½-inch refractor, a power of 5x and a 4-degree field. Denning has suggested the Ring nebula M57 in Lyra as a test object; any telescope to be seriously used in comet hunting should make it recognizable.

Where is it best to search for comets? Most of them are bright enough to be observable only when they are near the perihelion points of their orbits, and at the same time not too distant from the earth. Hence, the region in space containing the comet hunter's most likely prey lies between the earth and the sun, and the best parts of the sky are those near the sun. One should look low in the western sky just after dark, in the east before dawn, and under the celestial pole during the middle hours of the night.

In other parts of the sky, comets generally tend to be fainter, and such regions need large instruments for effective patrol.

How are comets searched for? The basic requirement is to inspect a large sky area so thoroughly that a sufficiently bright comet within it will not escape recognition. What the hunter hopes to find is apt to be a dim, diffuse glow, only a few minutes of arc in diameter. To illustrate the technique, suppose that you are about to search the western sky as twilight ends, with an altazimuth-mounted instrument.

The sky adjoining the horizon should be surveyed first, as this is about to be lost to view. The telescope is clamped in altitude, and then is slowly swung in azimuth, deliberately enough to prevent overlooking an inconspicuous comet. At the end of the sweep, move the telescope upward by about half a field's width (to insure overlap), and make a second sweep in the reverse direction. This pattern of sweeps continues in similar fashion until the entire area has been covered.

During this process, if a suspicious object is noted, it should be examined with a higher power. Often the suspect is thus revealed as a mere grouping of faint stars, or as a cluster. Checking in a star atlas (the Skalnate Pleso *Atlas of the Heavens* is by far the best for this purpose) will show whether the object is a known cluster or nebula. Most suspects will have been crossed off by this stage of checking.

The decisive test for a comet is motion. Make a careful drawing of the object's location among the field stars. Repeating this at hourly intervals will show the shifting position of a true comet. Even better for this than drawings is the ring micrometer, whose construction and use are explained in chapter 18 of J. B. Sidgwick's *Amateur Astronomer's Handbook*. Remember that the circular edge of your telescope's field of view can be used as a rough ring micrometer.

Is the comet a new discovery? If an object has met the tests just mentioned, it may still be a previously known comet. Recent *Harvard Announcement Cards* tell the whereabouts of comets already under observation, and the annual *Handbook* of the British Astronomical Association contains predicted positions of periodic comets whose returns are expected.

Scrupulous checking against possible blunders is the duty of anyone who thinks he may have found a new comet. Most "discovery" reports by inexperienced observers do not stand up. The need for double checking is indicated by an experience of mine some 15 years ago at the Warner and Swasey Observatory.

On a winter night I was standing outside the observatory, making binocular observations of some variable stars in Cassiopeia, then near the northern horizon. There I saw a large, fuzzy object, strikingly cometary in appearance. I asked Dr. J. J. Nassau to come outdoors to verify it. "Look just to the left of Kappa Cassiopeiae," I said. Standing some yards away, he replied, "Yes, I see it, but it's to the right of the star." The "comet" had such a large paraliax that it was clearly just a few hundred feet distant, and it proved to be only a lump of damp snow on a telephone wire, illuminated by a street light!

When you have taken a photograph that seems to show a new comet, make a visual check or more exposures to be sure it is not just a defect in the emulsion.

If you do find a bonafide comet that meets all tests, send a prompt notification with all essential details by prepaid telegram to Harvard Observatory Announcements, Cambridge, Mass. (Eastern Hemisphere discoverers should notify Observatory, Copenhagen, Denmark.) Your message should tell the comet's right ascension and declination, the corresponding time of observation, and, if possible, the direction and rate of motion per day. The report should include the estimated brightness of the comet, and facts about its appearance to facilitate its reobservation. You should state whether the discovery was photographic, and indicate the instrumental means. It is better to add information than be too brief. Follow up your telegram with a letter.

Any observer who takes up comet hunting must be prepared for long months of work before his first discovery. Denning recounted that during one 18-month period, around the turn of the century, he swept for comets with his 10-inch reflector on 78 nights, a total of 155½ hours. His bag was 141 telescopic meteors, 10 unlisted nebulae—and one comet.

JOSEPH ASHBROOK

# The Hyades Cluster

Otto Struve

*Leuschner Observatory*
*University of California*

**The Hyades cluster, together with the bright star Aldebaran, gives a V-shaped form to the face of Taurus, the Bull. This reproduction is enlarged from a 10-minute exposure by Walter J. Semerau with a K-19 aerial camera at f/3.5. The stars may be compared with their counterparts in the chart below.**

THE STAR CLUSTER of the Hyades is located in the constellation Taurus, not far from the Pleiades, forming a conspicuous pattern of naked-eye stars resembling the letter V. This famous stellar grouping has been familiar to watchers of the skies since prehistoric times. The brilliant orange star Aldebaran appears almost in the middle of the Hyades, but it is not a member of the cluster, being several times as far away.

This naked-eye group is, however, only the central part of a much larger cluster of stars. Centered at right ascension $4^h$ $20^m$, declination $+16°$, the Hyades cover a roughly circular region in the sky some 25 degrees in diameter. The surface area of the cluster is therefore about 500 square degrees, or 2,000 times the size of the disk of the full moon.

Yet the number of cluster stars is not very large. In his exhaustive study of the motions of the stars in the Hyades, the Netherlands astronomer H. G. van Bueren in 1952 counted 132 members brighter than apparent magnitude 9.0. He has listed about two dozen additional stars probably belonging to the group. Furthermore, the cluster presumably contains many more faint red stars, for which membership has not yet been ascertained, and there may also be some additional white dwarfs. The total number, van Bueren has estimated, may be as large as 350.

The striking feature of the Hyades, compared with other galactic clusters, is its motion. Its individual stars have large proper motions, about 0.1 second of arc per year, and all are directed toward a convergent point about 26 degrees away, at right ascension $6^h$ $08^m$, declination $+9°$, close to the meeting place of the constellations Orion, Gemini, and Monoceros. Thus the Hyades form a *moving cluster*, receding from us at an angle, with a radial velocity of about 40 kilometers per second.

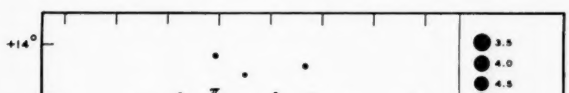
The most recent work on the motion of the Hyades comes from J. A. Pearce, at the Dominion Astrophysical Observatory in Victoria, B. C. This Canadian astronomer has used determinations of radial velocities more accurate than were hitherto available, and his discussion has also utilized greatly improved proper-motion data obtained by H. R. Morgan, U. S. Naval Observatory, and from the Cincinnati Observatory.

During the past 40 years, nearly 1,500 radial velocity determinations of 142 stars in the Hyades have been made at 10 different observatories. More than 600 of these, or 42 per cent of the total, were secured with the 72-inch reflector at Victoria, mostly by R. M. Petrie.

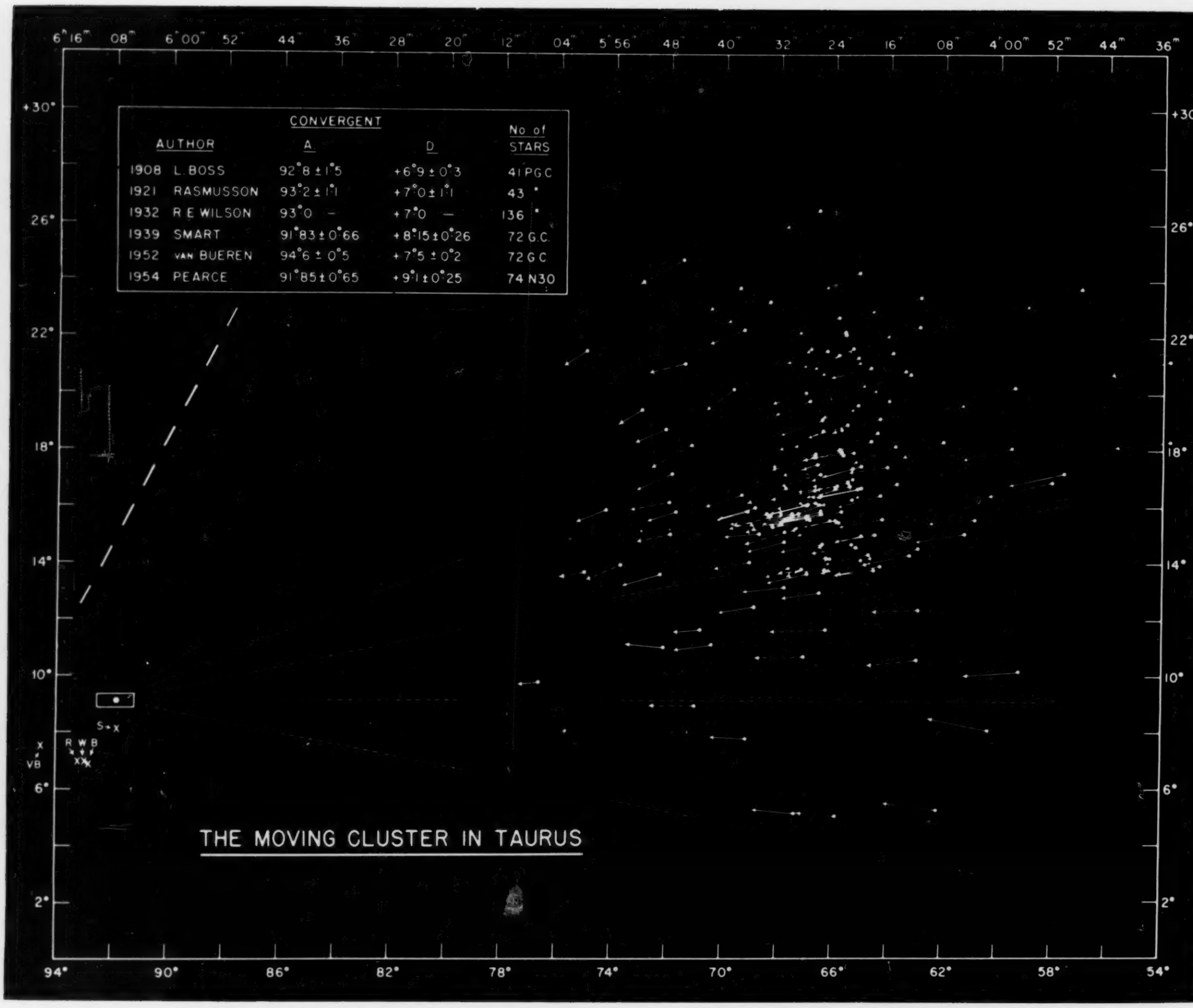
In the diagram by Dr. Pearce, on the next page, Hyades stars are represented by dots. The direction and the relative amount of their proper motions are shown by the arrows. The convergent point of the cluster is well determined, and lies about one degree north of the positions previously derived from less accurate data by Lewis Boss and others. This difference results partly from small systematic errors in the proper motions used in the earlier discussions. The new convergent point appears to be accurate to within considerably less than a degree.

This remarkable tendency of the Hyades proper motions to converge to a single point in the sky suggests strongly that the cluster stars are moving with equal velocities in parallel paths through space, away from the sun. If the cluster were approaching, the arrows in the diagram would diverge; there would be no convergent point, but instead a radiant—like the radiant point of a meteor shower.

This property of the Hyades allows us to find the distances to individual cluster stars with rather high accuracy. The method is based on the fact that radial velocities are measured in kilometers per second, while proper motions are ob-




**Stars to as faint as visual magnitude 10½ are shown in this map of the inner Hyades, adapted from the atlas of O. Kohl and G. Felsmann. South is upward, corresponding to the view in an inverting telescope. At the center of the chart are θ¹ and θ² Tauri, forming a coarse naked-eye double star. Not far from them an open circle indicates the long-period variable star W Tauri. This is one of the best studied regions in the sky.**




**The proper motions of the Hyades stars show a striking convergence, as illustrated in this diagram by J. A. Pearce. The insert table summarizes various determinations of the right ascension (A) and the declination (D) of the convergent point, which are plotted as crosses near the left-hand edge of the chart. The small rectangle indicates the uncertainty of the latest convergent position found by Dr. Pearce. Dominion Astrophysical Observatory diagram.**

served in seconds of arc per year. Since in the case of a Hyades star we can tell the actual direction of motion of the star through space, we can combine the radial velocity and the proper-motion data in the following way to tell the star's distance.

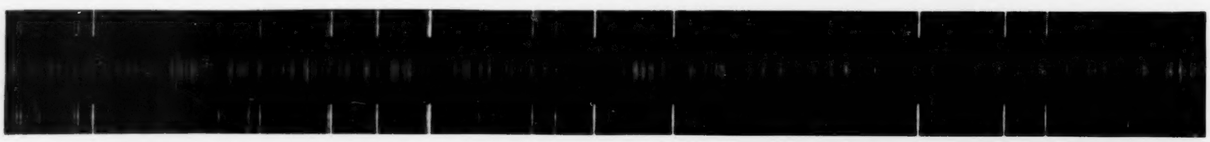
Let us suppose that four stars belong to a moving cluster, as shown opposite. All of these stars have the same space motion, *S*. Star A in the diagram is moving directly away from the sun; its proper motion is zero and its radial velocity equals *S*. Star B has a small proper motion, in the direction of the convergent point; C has a larger proper motion, also pointing toward the convergent. Lastly, star D has the largest proper motion, and its radial velocity is zero. In all cases, the angle that the space motion *S* makes with the line of sight is equal to the angular distance on the celestial sphere between the star and the convergent point, and thus is easily found.

If we measure this angle, $\lambda$, for a cluster star whose radial velocity *R* has been observed, the space motion of this star can be derived from a simple right triangle. In trigonometric terms,

$$S = R \sec \lambda,$$

but *S* could also be found by scaling off the drawing. There *T* is the component, at right angles to the line of sight, of the space motion. It too can be scaled from the diagram, or computed from the trigonometric expression

$$T = S \sin \lambda.$$



**Radial velocities of the Hyades stars were measured at Victoria from spectrograms such as this one secured with the 72-inch reflector. This is the spectrum of the star Gamma Tauri, magnitude 3.7, a yellow giant of spectral type G9. The emission lines above and below the star's spectrum are from a laboratory source, to provide a scale of wave lengths. Dominion Astrophysical Observatory photograph.**

Since the radial velocity $R$ is given in kilometers per second, when it is found from the Doppler displacement of the spectral lines of a star, $S$ and $T$ are also expressed in the same units.

Observation has given us the proper motion $\mu$ of the star, in seconds of arc per year. The quantities $T$ and $\mu$ are easily related to one another. One way is by thinking of the number of kilometers the star travels in a year, in the projection of its space motion on the sky. If the distance of the star is $d$ kilometers, the star moves

$$2\pi\, d \times \frac{\mu}{360^\circ \times 60' \times 60''}$$

in a year. But this is equal to $3.2 \times 10^7\, T$, the tangential velocity multiplied by the number of seconds in a year. Then we may equate these two expressions and solve for the star's distance $d$. In this way we can tell how far away the Hyades are, without recourse to ordinary stellar parallax measurements.

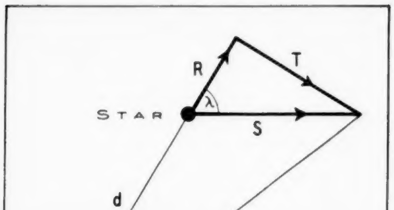
In applying this method, Pearce has found that the best determination of $S$ comes from the radial velocities of the

RADIAL VELOCITY AND SPACE MOTION OF THE TAURUS CLUSTER

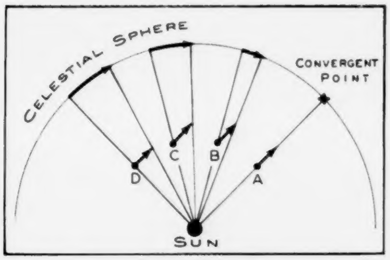
| *Star H.D. No.* | *Visual Magnitude* | *Spectral Type* | *Radial Velocity* Lick | No. | Victoria | No. | *Value of R km./sec.* | *Value of S km./sec.* | *Wt.* |
|---|---|---|---|---|---|---|---|---|---|
| 25570 | 5.38 | d*F*2 | +36.0 | 4 | +36.4 | 16 | +36.3 ± 0.3 | 42.4 | 2 |
| 27371 | 3.68 | g*G*9 | +38.5 | 10 | +38.6 | 12 | +38.6 ± 0.2 | 43.6 | 6 |
| 27697 | 3.77 | g*G*8 | +38.5 | 7 | +38.1 | 11 | +38.3 ± 0.3 | 43.1 | 4 |
| 27934 | 4.11 | d*A*5n | +41.3 | 5 | +37.9 | 15 | +39.0 ± 0.6 | 44.3 | 2 |
| 27962 | 4.24 | *A*3 | +36.3 | 4 | +37.8 | 15 | +37.4 ± 0.3 | 41.9 | 2 |
| 28305 | 3.52 | g*G*8 | +39.1 | 9 | +37.8 | 4 | +38.7 ± 0.3 | 43.3 | 3 |
| 28307 | 3.87 | g*G*8 | +37.7 | 5 | +37.8 | 4 | +37.7 ± 0.5 | 41.8 | 1 |
| 28527 | 4.71 | sg*A*8n | —— | — | +40.6 | 5 | +40.6 ± 0.8 | 44.9 | 1 |
| 28546 | 5.40 | d*A*7 | +41.1 | 3 | +39.2 | 16 | +39.6 ± 0.5 | 43.8 | 2 |
| 30210 | 5.43 | d*A*5p | +35.6 | 2 | +39.2 | 5 | +38.2 ± 0.8 | 40.9 | 1 |

Weighted mean of space velocity $S$ = +43.2 ± 0.13 km./sec.

10 brightest stars of the Hyades. His results are summarized in the table above. The average space motion of the cluster




**The space motion of a star is S in this diagram. It can be resolved into radial and tangential components R and T, respectively. The star's distance from the sun is d, and its proper motion is the angle $\mu$. The angle between the space motion and the line of sight to the star is $\lambda$.**




**Compare the projections on the celestial sphere of the space motions of the stars shown here, to understand why the members of a moving cluster have proper motions whose size depends on their angular distances from the convergent point.**

is 43.2 kilometers per second. This value has an uncertainty of the order of only 0.1 kilometer per second—by far the most accurate determination of the motion of any star group.

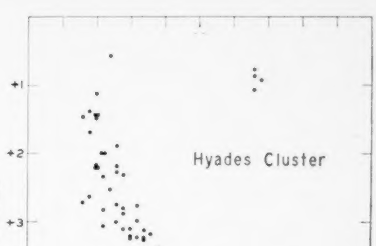
For the distance to the center of the Hyades cluster, Pearce finds 37 parsecs or about 120 light-years. However, the diameter of the cluster is very considerable, about 20 parsecs. Hence, the nearest Hyades stars may be as close as 27 parsecs from the sun, while others are 47 parsecs away.

Another important conclusion can be drawn from Pearce's table of the radial velocities of the 10 brightest Hyades stars. It will be noticed that the spread in the individual values of $S$ is very nearly the same as the differences between the Lick and Victoria measurements of the radial velocities. If the space motions were not the same, their dispersion would be larger than the Lick-minus-Victoria differences would imply. It is therefore certain that the true space motions of the individual stars differ only very slightly from their average of 43.2 kilometers per second, probably by not more than 0.5 kilometer per second. Thus there is no expansion of the cluster as a whole, nor any appreciable rotation. Nor are there any detectable random motions of the stars within the cluster.

According to van Bueren, the cluster is slightly flattened, with its longest diameter approximately parallel to the plane of the galaxy. On examining the distribution of stars of different spectral types, he noted that the *K*-type giants are more concentrated toward the center of the Hyades than are the main-sequence stars.

With the help of the individual distances of the Hyades stars, Pearce was able to derive their absolute magnitudes, making use of O. J. Eggen's photoelectric measurements of apparent magnitude, and to plot the H-R diagram of the Hyades. Although Pearce does not specifically state the source of the spectral types he used, presumably they are based on Victoria spectrograms. The brightest star is a giant of spectral class *A*7, $\theta^2$ Tauri, whose absolute magnitude is +0.7. The diagram shows only one subdwarf, BD +13° 671, of spectral type *G*2 and absolute magnitude +7.2, about two magnitudes fainter than the main sequence. But this is evidently not a chance background star; Pearce concludes from its radial velocity and proper motion that it is a genuine member of the cluster.

This wealth of observational facts concerning the Hyades could be gathered because of its closeness to us, as galactic clusters go. However, in the remote future, this giant group will shrink to a far less striking object as it continues to recede from us. Lewis Boss pointed out—from early data that need little revision today—that some 65 million years hence the Hyades will appear as a small, condensed star cluster some 20 minutes of arc in diameter, whose brightest stars will be of the 9th magnitude—a fairly typical telescopic cluster.




**The Hertzsprung-Russell diagram for stars belonging to the Hyades, as plotted by J. A. Pearce. Dominion Astrophysical Observatory diagram.**

# Islands in the Path of the 1958 Total Eclipse

H. von Klüber
*Cambridge University Observatory*

**The eclipse of June 8, 1937, had a corona typical of sunspot maximum, as expected in 1958, and the shadow paths of the two eclipses are roughly parallel.**

ASTRONOMERS are looking forward to the next total eclipse of the sun, on October 12, 1958, with an interest that is not dampened by memories of the latest one, on June 20, 1955, when practically all expeditions were beaten by poor weather. Total eclipses provide the only opportunities for certain urgently needed observations of solar phenomena. The information that the 1958 eclipse can provide concerning the sun's atmosphere and corona will be of special interest in connection with the International Geophysical Year.

When the moon hides the sun on that October day two years from now, the first glimpse of the total eclipse will be at sunrise at a point north of the Solomon Islands and nearly on the equator. The moon's shadow will sweep eastward across the South Pacific Ocean, and the path of totality will end at sunset just within the west coast of South America. The partial phases of the eclipse will be visible from eastern Australia, New Zealand, the islands of Polynesia, and the western and southern parts of South America.

Yet, in all this vast region, and along the 9,000-mile shadow track, useful observations of totality will be possible from only a few small islands in the South Pacific.

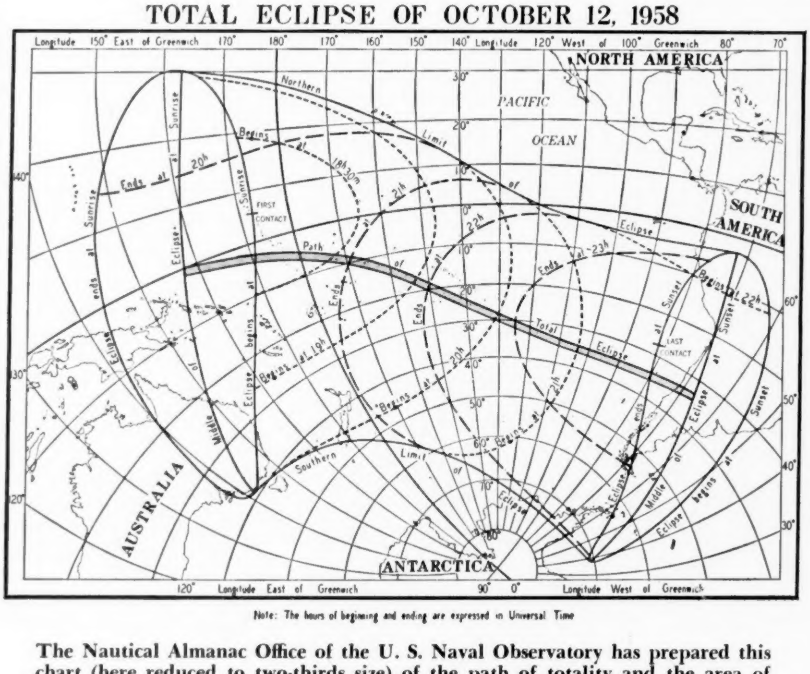
Preparations for an eclipse expedition can never be started too early. Therefore, I have already collected some information about the islands in the path of totality, and summarize it here. The tabular data concerning the eclipse is approximate and intended only for orientation; it was obtained graphically and should eventually be checked by exact calculations of the local circumstances for each observing station.

Of the possible expedition sites described here, the westernmost is Atafu, an atoll four miles in diameter, in the Union group north of the Samoa Islands. It abounds in coconut palms, and has a village and a hospital. An occasional steamer from Samoa comes to its good anchorage to load copra.

Next to the east is the island of Nukunono, whose geographical position is somewhat doubtful, so that the eclipse predictions for this station have additional uncertainty. Landing is difficult on this 8-by-6-mile atoll, which had 450 inhabitants in 1951.

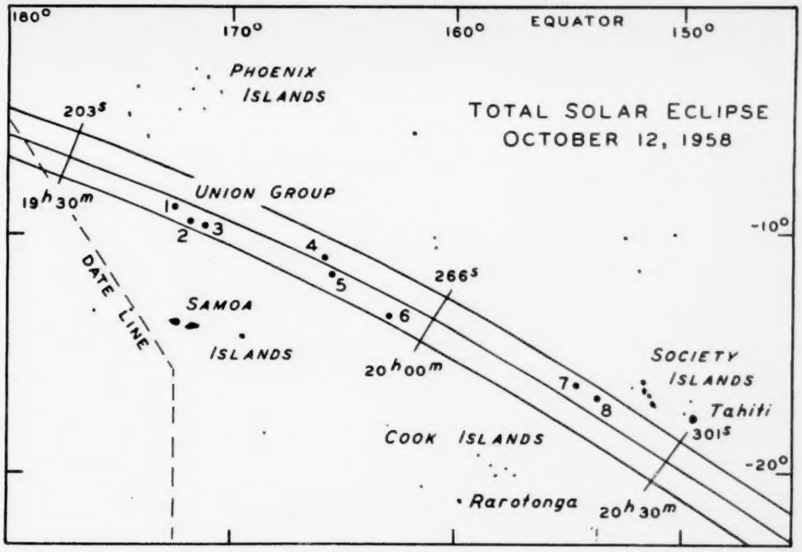
Close by is Fakaofo, consisting of several wooded islands on a reef seven miles long. There is a village, but the only landing is by canoe. This atoll was discovered by the American ship *Peacock* in 1841.

TOTAL ECLIPSE OF OCTOBER 12, 1958




Note: The hours of beginning and ending are expressed in Universal Time

**The Nautical Almanac Office of the U. S. Naval Observatory has prepared this chart (here reduced to two-thirds size) of the path of totality and the area of the earth covered by the penumbra of the moon's shadow.**




**This chart shows the duration in seconds along the path of totality, with the Universal time given for mid-eclipse. The moon's shadow passes near but misses such well-known places in the South Seas as Tahiti and the Samoa Islands. The eight islands within the path are indicated by numbers that correspond to those in the table below.**

| | *Island* | *Longitude (west)* | *Latitude (south)* | *Local time of totality* | *Altitude of sun* | *Duration of totality* | *Distance** | *Width of path* |
|---|---|---|---|---|---|---|---|---|
| 1. | Atafu | 172° 30′ | 8° 33′ | 8:07 a.m. | 37° | 204 sec. | −38 km. | 195 km. |
| 2. | Nukunono | 171 53 | 9 10 | 8:10 | 37 | 142 | −74 | 195 |
| 3. | Fakaofo | 171 15 | 9 23 | 8:14 | 37 | 153 | −70 | 195 |
| 4. | Danger Islands | 165 50 | 10 55 | 8:46 | 45 | 242 | +18 | 200 |
| 5. | Nassau Island | 165 25 | 11 33 | 8:48 | 46 | 240 | −24 | 200 |
| 6. | Suvarov Islands | 163 5 | 13 15 | 9:04 | 50 | 164 | −77 | 200 |
| 7. | Scilly (Fenua Ura) | 154 32 | 16 29 | 9:59 | 62 | 232 | +60 | 210 |
| 8. | Mopélia | 153 55 | 16 48 | 10:03 | 63 | 230 | +63 | 210 |

* Distance from the central line, positive if the island is north of the line.

None of the islands in the path is on or very near the central line. Because the Danger Islands are only about 11 miles north of the line, the duration of totality there will probably be greater than for any of the other sites. Here are three wooded islands, each with its village, forming an atoll about seven miles long. The 700 inhabitants speak Rarotongan, and live under New Zealand administration. While schooners occasionally visit the Danger Islands, landing is extremely hazardous and is possible only by small craft at high tide.

Nassau Island, next to the east, is also near to the central line and will have four minutes of totality. Only one mile long, this low-lying wooded island contained some natives in 1937, but in 1949 it was reported to be uninhabited. Ships visit here about twice a year, but landing is difficult.

The Suvarov Islands form an atoll about 10 miles long, reportedly under lease to a trading company. The group is apparently uninhabited, but natives from Rakahanga and Palmerston Islands come to collect copra. There is an anchorage and small pier, but no water supply other than a tank to collect rain water.

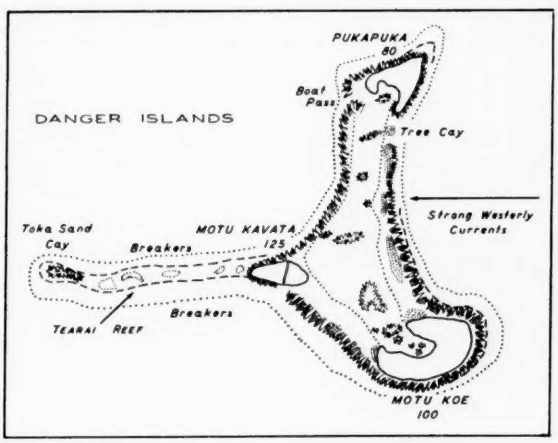
The two French protectorates of Mopélia and Scilly (formerly Fenua Ura) lie about 600 miles farther east. These are two small atolls, each with a few inhabitants. Both sites are noteworthy for the relatively long duration of totality, nearly four minutes, and for the great altitude of the sun at mid-eclipse.

Only very meager information on weather conditions at these eight islands is available so far. For morning hours during October the cloudiness is 4 to 5 for the more easterly islands, and 6 to 7 for the western ones; the cloudiness is expressed in tenths of the sky covered. Temperatures will be rather uniformly between 70° and 90° Fahrenheit, with a relative humidity of about 80 per cent. Rainfall can be expected on between 6 and 17 days in October, reaching a total of 2 to 14 inches. September seems the driest month on the Danger Islands, where weather records were kept from 1929 to 1942.

All of these islands lie in the belt of the southeast trade winds, and storms or gales should be uncommon in October. Winds should blow exclusively from the east with an intensity of about 2 to 3 on the Beaufort scale. Hurricanes occur about once a year in this region of the Pacific, and the chance of an island being struck is small. Nevertheless, a hurricane caused much damage on Atafu in 1914.

More information concerning weather conditions is being collected, together with other circumstances of concern to eclipse expeditions. This data will be available to astronomers from the author.

All of the islands within the path of totality appear to be very isolated from the rest of the world, and astronomers may find it difficult to reach them. The landing problem in some cases might best be solved by helicopter. It is hoped that some co-operative arrangement for transportation can be organized among the various expeditions, for astronomers throughout the world are interested in observing this eclipse.




**Among the most favorable of the South Sea island sites for observing the eclipse are the Danger Islands. The landing place is on the west side of Pukapuka Island, where the government's resident agent lives; it is reached through a cut in the otherwise unbroken barrier reef. The natives travel freely by canoe between the three islands, as the lagoon is mostly deep and clear. Island heights are indicated in feet. The scale is about 2½ nautical miles to an inch.**

EDITOR'S NOTE: A standard source of information on these potential expedition sites is H. O. 166, *Sailing Directions for the Pacific Islands*, Vol. III (sixth edition, 1952), available from the U. S. Hydrographic Office, Washington 25, D.C. For these seldom-visited islands, this publication gives geographical positions that may differ by several miles from those cited by Dr. von Klüber in his table, and there is considerable detailed information, sometimes at variance with his synopsis.

# NEWS NOTES

By Dorrit Hoffleit

### *AN UNUSUAL ECLIPSING VARIABLE*

In *Bulletin* 464 of the Astronomical Institutes of the Netherlands, J. Ponsen, Leiden Observatory, describes a peculiar eclipsing variable star in Scorpius. It is nearly of naked-eye brightness, changing from magnitude 6.8 to 7.3 with a period of 3.28 days.

Secondary minimum does not occur midway between the primary minima: instead the variable dims to magnitude 7.3 at intervals of 0.80 and 2.48 days. Accordingly, the orbit of this eclipsing binary system must be highly elongated, with an eccentricity of at least 0.4, which is very unusual for a double star whose period is so short.

Dr. Ponsen's 300 plates from the Union Observatory, Johannesburg, South Africa, were insufficient to show the true period, which was established by J. de Kort, of the Vatican Observatory, from photographs taken at Riverview Observatory, Australia.

The variable is the brighter component of the visual double star h5000, and has a 9.5-magnitude companion eight seconds of arc distant, first recorded by John Herschel in 1837. The position for 1950 is $17^h$ $55^m.8$, $-36°$ $57'$.

### *MARTIAN CLIMATE*

"The rigor of the Martian temperature climate, although undeniable, has perhaps been overemphasized in comparisons with the earth," Frank Gifford, Jr., has reported in the *Astrophysical Journal*. One reason, he points out, is that measures of Mars' temperatures refer to the actual surface of the planet, while terrestrial data are taken several feet above the ground level where temperature changes are less marked.

Mr. Gifford is now with the U. S. Weather Bureau, Oak Ridge, Tenn. While at Lowell Observatory several years ago, he studied some 1,300 observations of Martian temperatures made by C. O. Lampland from 1926 to 1943 with the Lowell 42-inch reflector and sensitive thermocouples. Hitherto only a small part of this extensive material had been analyzed.

At the Martian equator, midday temperatures of 44° Fahrenheit are typical, but the daily range is large, amounting to perhaps 50 degrees. As on Earth, the highest temperature comes after noontime, by about 1 to 1½ hours for Mars. Similarly, the warmest part of the Martian summer comes about 60 days after the planet's summer solstice, although the lag for the rest of the year is not nearly as great as this.

Detailed maps were drawn by Mr. Gifford, showing the distribution of temperature over the surface of Mars in different seasons. The green regions are warmer on the average than the reddish "deserts." However, the contour lines of equal temperature do not match in detail the outlines of the surface markings, partly because the thermocouple averages large portions of the planet's apparent disk, but mainly because the temperatures are more closely related to Mars' atmospheric circulation than to surface topography, according to Mr. Gifford.

### *SILICON-CARBON MOLECULES IN N-TYPE STARS*

A system of blue-green bands in the spectra of *N*-type stars, discovered by P. Merrill and R. F. Sanford in 1926, has remained unidentified until recent laboratory experiments by Bengt Kleman, of the National Research Council of Canada. By heating silicon in an electric furnace to temperatures of 2,200° to 2,500°, he was able to reproduce these spectral features and measure accurate wave lengths.

Comparison of the laboratory spectra with the spectra of *N*-stars, particularly with Sanford's high dispersion spectra of VX Andromedae, makes the identification appear certain. Kleman attributes the bands to the molecule Si-C-C, which contains one atom of silicon and two of carbon. In his report in the *Astrophysical Journal*, he also notes the appearance of a strong continuous spectrum during these experiments. This continuum, he suggests, may be related to the strong ultraviolet absorption found in stars showing the blue-green bands.

### *SHARPER PLANET PICTURES*

Fine color photographs of Jupiter, Mars, and Saturn have been obtained at the Mount Wilson Observatory by Robert B. Leighton, using the 60-inch reflector and a special device designed to overcome some of the effects of poor seeing. His pictures are reproduced in the June issue of *Scientific American*, where he describes his method in detail, writing:

"During the past few years . . . I observed that during good seeing the image of a planet tends to move as a whole, rather than to change in size or shape. This motion is erratic, but the image remains within one or two seconds of arc of some average position. Most important, the image moves slowly enough so that the design of an electromechanical servo system capable of following it appeared practical."

Dr. Leighton has succeeded in reducing the motion of a planetary image on the film to a tenth its amount if uncompensated. He uses an f/4.5 enlarging lens, mounted on a doubly pivoted carriage, and two photomultiplier tubes to which a fraction of the light is fed. These tubes actuate electromagnet coils that control the position of the lens and compensate for drifting of the image.

### IN THE CURRENT JOURNALS

SOLAR FLARE INDICATOR, by David Warshaw, *Radio-Electronics*, August, 1956. "The solar-flare indicator—actually an atmospheric radio receiver—is tiny. It sets off an alarm at the time of a solar flare, indicates the exact instant when shortwave communications will fade out and even forecasts magnetic and ionospheric storms and auroras 26 hours in advance."

COMETS AND PEOPLE, by Dinsmore Alter, *Griffith Observer*, July, 1956. "When we read these stories of the results of terror caused by the harmless approach of a comet [Halley's, in 1910] and realize how many people refused to listen to the sensible statements made by scientists, we should become rather humble. . . . We smile about these events of a half century ago, but some of us accept without question views even more exciting and less plausible concerning mysterious visitors from space who scan our actions here on earth today."

THE VOLCANIC-AEOLIAN HYPOTHESIS OF MARTIAN FEATURES, by Dean B. McLaughlin, *Publications*, Astronomical Society of the Pacific, June, 1956. "Interpretation of the surface of Mars is a geological (and meteorological) problem, requiring the application of geological methods of thinking, modified to suit Martian conditions."

TEKTITES AND THE LOST PLANET, by Ralph Stair, *Scientific Monthly*, July, 1956. "Tektites are small glass objects that have fallen to earth from outer space. . . . Recently tektites have become of interest to cosmologists. The study of the properties of these small glass objects may well lead to a better understanding of the origin of the solar system, and possibly of the universe itself."

### *CRAB NEBULA POLARIZATION*

Applying a technique of composite photography similar to that he used for the Whirlpool nebula (page 205, March issue), Dr. Fritz Zwicky has now studied the polarization of the light of the Crab nebula, M1, in Taurus, which is known to be the expanding remnant of a supernova outburst observed 900 years ago. This polarization was recently discovered by Soviet astronomers, and has been studied by observers in the Netherlands (*Sky and Telescope*, November, 1955, page 25).

He has superimposed the negative of one plate taken with a polarizing filter and the positive of another plate polarized at right angles to the first. In the resulting composite picture, alternating bright and dark areas form a peculiar pattern of rectangles in the central part of the nebula, where continuous spectral emission has been observed.

There is no simple explanation for this "basket-weave" structure, but Dr. Zwicky suggests that if it is inherent in

the nebula there may be appreciable changes within a few years. His pictures are published in the April issue of the *Publications* of the Astronomical Society of the Pacific.

### *METEORS AID SHORT-WAVE RADIO COMMUNICATION*

Radio wave lengths as short as those used for line-of-sight transmission, as in television broadcasting, can now be employed over distances as great as 1,000 miles, by taking advantage of the ionized particles in meteor trains some 60 miles above the earth's surface.

This remarkable result has been achieved by Canadian scientists in a recently declassified project known as JANET. P. A. Forsyth, of the Radio Physics Laboratory, Ontario, first proposed using meteor trails in this way. Special rapid sending and receiving equipment had to be perfected, because the trail of any one meteor can be used for only about a second. But there are enough of the required pinhead-sized meteors entering the atmosphere to make possible fairly fast transmission of long messages.

When a suitably located meteor train appears, a message previously stored at one station instantly begins to be transmitted to the other station, and the transmission is cut off when the train fades. Because the meteor train is of brief duration, the message is sent in short bursts at very high speed; electronic storage devices at the receiver hold the message until it can be printed at normal speed during the intervals between the bursts of transmission.

The new technique has special value in Canada, for the VHF (very high frequency) signals are almost unaffected by ionospheric disturbances, such as accompany the aurora borealis.

### *INFRARED OBSERVATIONS OF A LUNAR ECLIPSE*

When the moon undergoes a total eclipse, the temperature drop at the lunar surface is large and sudden, but even a few centimeters below the surface the drop is less and lags behind the surface changes. Observations of this effect have indicated that a thin layer of dust, with very low heat conductivity, covers the moon.

In the *Astrophysical Journal* for March, William M. Sinton, of Harvard Observatory, reports measurements during the total lunar eclipse of January 18-19, 1954, when he was at Johns Hopkins University. He used a Golay infrared-sensitive cell attached to a 24-inch searchlight mirror which served as a telescope; the peak sensitivity was at a wave length of 1.5 millimeters, and the instrument was calibrated by readings on the sun.

The moon's temperature dropped from 300° above absolute zero, before the eclipse began, to about 170° as totality started, and it remained near this level even after the earth's umbral shadow had passed off the moon. From his data, Dr. Sinton deduces that the heat conductivity of the lunar surface layer is similar to that of terrestrial basalt in powdered form.

However, such measures give only an average over the entire face of the moon, and temperature data for smaller areas would be more informative, Dr. Sinton points out. He plans to make infrared observations with Harvard's 61-inch reflector of the total eclipse on November 18th.

### *OPTICAL SOCIETY MEETING*

The 41st annual meeting of the Optical Society of America will be held at the Lake Placid Club, Essex County, N. Y., October 18-20.

The program is to include papers on the International Geophysical Year, on optical fibers for transmitting images, on new light sources, and on new infrared optical materials. Rudolf Kingslake, Eastman Kodak Co., is chairman of the program committee. The meeting is open to nonmembers.

### *SMALLER EARTH*

The longest arc ever surveyed on the earth stretches from Finland to the southern end of Africa, a distance of 5,777.5 nautical miles. The European section of the line was measured by standard methods, and completed in 1951. Shoran was then used to extend the arc across the Mediterranean to Egypt. Hampered by wild buffaloes and grass fires in the Sudan, the survey was pushed from Khartoum to Uganda, and finally completed in 1954.

Now the U. S. Army Map Service has carried out all the calculations necessary to determine the size of the earth; the computations would have required 10 years if a Univac computer had not been used. The earth's equatorial radius comes out 6,378,260 meters, 128 meters shorter than the best previous value. In miles, the new radius is 3,963.26, and the equatorial circumference is slightly under 24,902 miles.

### *SCANNING FOR VARIABLE STARS*

A novel device for the automatic detection of variable stars has been built at the Kapteyn Astronomical Laboratory in Holland. It uses television techniques. Two star photographs taken at different times are scanned simultaneously, the video signals of one being subtracted from the signals of the other. The resulting television picture shows only the stars that have changed in brightness between the two photographs. Early tests with this instrument, using photographs taken with the Palomar 48-inch Schmidt telescope, are described by J. Borgman in the *Observatory*.

In scanning these plates, no details were lost unless masked by plate grain. The 14-inch television screen portrayed one square centimeter of the plate at a time. Variables brighter than magnitude 16 on the Palomar photographs showed as rings, fainter variables as dots. This is because the brighter images differ mainly in diameter, while fainter images differ chiefly in density.

The scanner could equally well be used for the discovery of stars having large proper motions, Dr. Borgman points out.

### *A NEW HERSCHEL LETTER*

When William Herschel discovered the planet Uranus, the Royal Society awarded him its Copley medal. Before the presentation, however, Sir Joseph Banks wrote on November 15, 1781, to Herschel asking for "such anecdotes of the difficulties you have experienced in the discovery, &c, as you may think proper to assist me in giving due praise to your industry and ability."

Now Sir Eric Miller has presented to the Royal Astronomical Society the hitherto unpublished letter Herschel wrote in reply to this request. It appears in the R.A.S. *Occasional Notes*, 3, 18, February, 1956. Herschel's first paragraph reads:

"This new star could not have been found out even with the best telescopes had I not undertaken to examine every star in the heav'ns including such as are telescopic, to the amount of at least 8 or 10 thousand. I found it at the end of my second review after a number of observations not less than 15 thousand; so that the discovery cannot be said to be owing to chance only it being almost impossible that such a star should escape my notice."

### *MARTIAN CLOUD*

The formation of an enormous yellow cloud in the atmosphere of Mars has been reported by Dr. G. P. Kuiper, from the McDonald Observatory in Texas. He first saw it on August 30th, at $8^h$ UT, as about 1,000 miles long, over the Mare Sirenum area. The cloud had not been present on the morning of August 29th. But at $8^h$ UT on August 31st, the ribbon-like cloud was roughly 250 miles wide and 3,000 miles from tip to tip, in the shape of a W.

At Lowell Observatory on September 1st, about $6^h$ UT, visitors viewing Mars with the 24-inch refractor noted that the surface markings were unusually indistinct, as if obscured by haze in the planet's atmosphere. The veteran planetary observer, Clyde Tombaugh, remarked that he had never seen the Martian disk appear so washed out.

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**CAPTION CORRECTION**

The persons in the photograph at the foot of page 488 in the September issue are, left to right, Dr. Miguel Mery, Dr. James Q. Gant, and Dr. Boris Jaskovich, according to the photographer, Russell C. Maag.

# A Method for Timing Astronomical Observations

M. Francis*

PRECISE TIMING has always been important in certain kinds of astronomical observations: occultations of stars by the moon, contact times for solar eclipses and transits of Mercury, phenomena of Jupiter's moons, and the like.

And now amateurs are being called upon to watch for artificial satellites. Each observing station and group of visual observers will require reliable devices to time possible sightings. This article describes how readily available electronic equipment can provide the proper timing records. This method was used at Bellwood, Illinois, for several lunar occultations in 1955, two of which occurred only two minutes apart on the night of March 30-31. Had these happened to come just two seconds apart, their times and the interval between them could have been determined just as easily.

Many amateurs may already own one or more of the basic components of this timing system, which consists of a short-wave radio, a tape recorder, and a microphone mixer. The system can be used anywhere within the range of the National Bureau of Standards time-signal station WWV near Washington, D. C., or its associate WWVH in Hawaii, if 115-volt 50-60-cycle a.c. power is at hand. Where such power is not available, it can be provided at relatively small cost by a converter.

Picked up by the radio, a continuing background series of WWV time signals is fed by way of the microphone mixer to the tape recorder. Also fed in, by separate mixer input channels, are the observers' verbal announcements. These may include a spoken signal when the satellite is seen in one of the observing instruments, audible reading of the coordinate scales, and other measurements. The tape furnishes a permanent record of what each observer says and the exact time at which he says it; the tape may be played back as often as necessary.

*The Tape Recorder.* Being a veritable "electronic memory," the tape recorder forms the brain of this system. The model shown in the photograph is a Webcor 2711, about halfway up on the price scale of several suitable recorders now on the market at between $90 and $300. Tape recorders are sold by most electrical appliance dealers, music stores, television shops, and mail order houses.

Except if ordered specially, these home-type tape recorders operate on 50-60-cycle alternating current at 110 to 130 volts, the most common power in the continental United States. Plugging a standard tape recorder into any other type of power system, even for a short time, can do serious damage to it. But if only an uncommon power voltage is available, it is better to get a standard unit and use it with the correct converter than it is to order a special recorder. The power consumption of a tape recorder is negligible unless a converter is required.

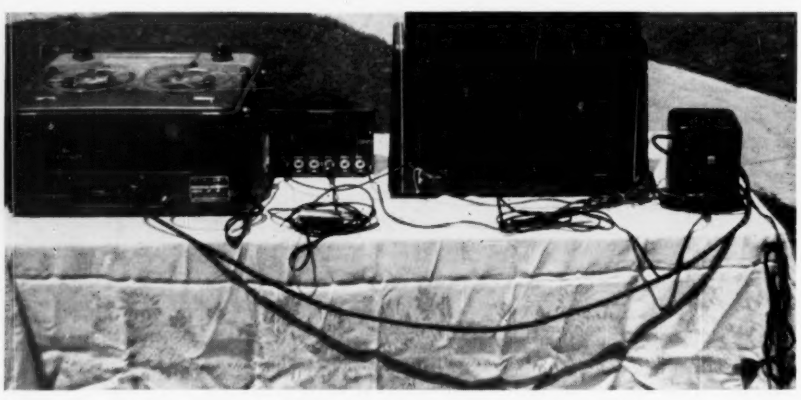
Recording and playback speeds of the recorder (the number of inches per second through the recording heads) are of no direct consequence in this application. Recorders usually have one or two operating speeds, in addition to a fast rewind. The Webcor 2711 will record and play back in both directions, eliminating the need to turn the reel over by hand and consequent loss of valuable recording time when the end of the tape is reached. The operator can skip ahead or backwards at will. In all tape recorders erasure is automatic, taking place when the tape is re-recorded. A recorded tape can be played thousands of times, or it may be erased and used over and over again.

A monitor switch is a good idea in a tape recorder, for it enables the user to listen to a recording while it is being made. Monitoring is necessary if insertion of the plug connecting the short-wave radio to the microphone mixer will cut off the radio loud-speaker. This is true of the Hallicrafters receiver shown in the photograph. The time signals, in this case, are being fed through the mixer to the tape recorder in electrical form and are being directly impressed upon the tape. However, they are inaudible during recording until the tape recorder switch is set to the monitor position.

*The Radio Receiver.* My Hallicrafters model TW-2000 is a three-way portable that operates on batteries or on 115-volt a.c. or d.c. Retailing for about $150, it covers the short-wave frequencies in six bands between 1.8 and 18.2 megacycles. Models with a little wider band coverage are made by Zenith, while Hallicrafters has a less expensive a.c.-d.c. model, the S-38D, priced close to $50 and covering the WWV frequencies. The Zenith models and the Hallicrafters TW-2000 can be purchased through most radio and television dealers, while the S-38D, together with a multitude of other receivers for amateurs, is offered by radio parts houses, such as Allied Radio in Chicago.

In the photograph, the back of the radio receiver is seen at the right. From its lower left corner run two connections; the one toward the right is from the small isolation transformer near the end of the table. Dangling from this is the cord used to plug into ordinary house current. The other connection runs to the left from the back of the radio to the microphone mixer. Like the cable used to couple the mixer to the tape recorder,





**This is a picture of the Francis equipment set up for use with ordinary house power. From left to right are the tape recorder, microphone mixer, microphone (below mixer), short-wave radio, and isolation transformer with power cord for plugging into the house outlet. All photographs by M. Francis.**

this lead is shielded and must terminate with the proper plug. Here are some typical cases:

For a Pentron microphone mixer, equipped with phone jacks in the input circuits, the cable connecting it to the TW-2000 output, which is also a phone jack, will have to be fitted at the radio end with a phone plug. For the S-38D, however, the radio end of the cable will need a set of phone tips, like those at the end of a pair of earphone leads. If the radio is a National SW-54, another $50 model, the cable will need a pin plug, like that on the end of a record-changer cable. In any case, the dealer who supplies the short-wave receiver can also provide the connecting cord if he knows what it will plug into.

The jacks on the short-wave receiver are designed for use with a pair of earphones, and thus there may be a mismatch of impedances in feeding the time signals to the mixer. This mismatch is not serious and does not affect the results in any way, as long as signal voltage is correctly adjusted by the volume controls on both the short-wave receiver and the microphone mixer.

For some localities, to bring in WWV in sufficient strength it may be necessary to install an outside antenna. The actual power requirements of the radio receiver are negligible when ordinary house power can be employed. For other kinds of current, a converter will be required.

*The Microphone Mixer.* The purpose of the mixer, with its separate volume controls governing separate input channels, is to balance the amplitude of the radio time signals, which are subject to fading, with the amplitude of the observer's voice. The tape recorder has its own volume control and re-recording-level indicator.

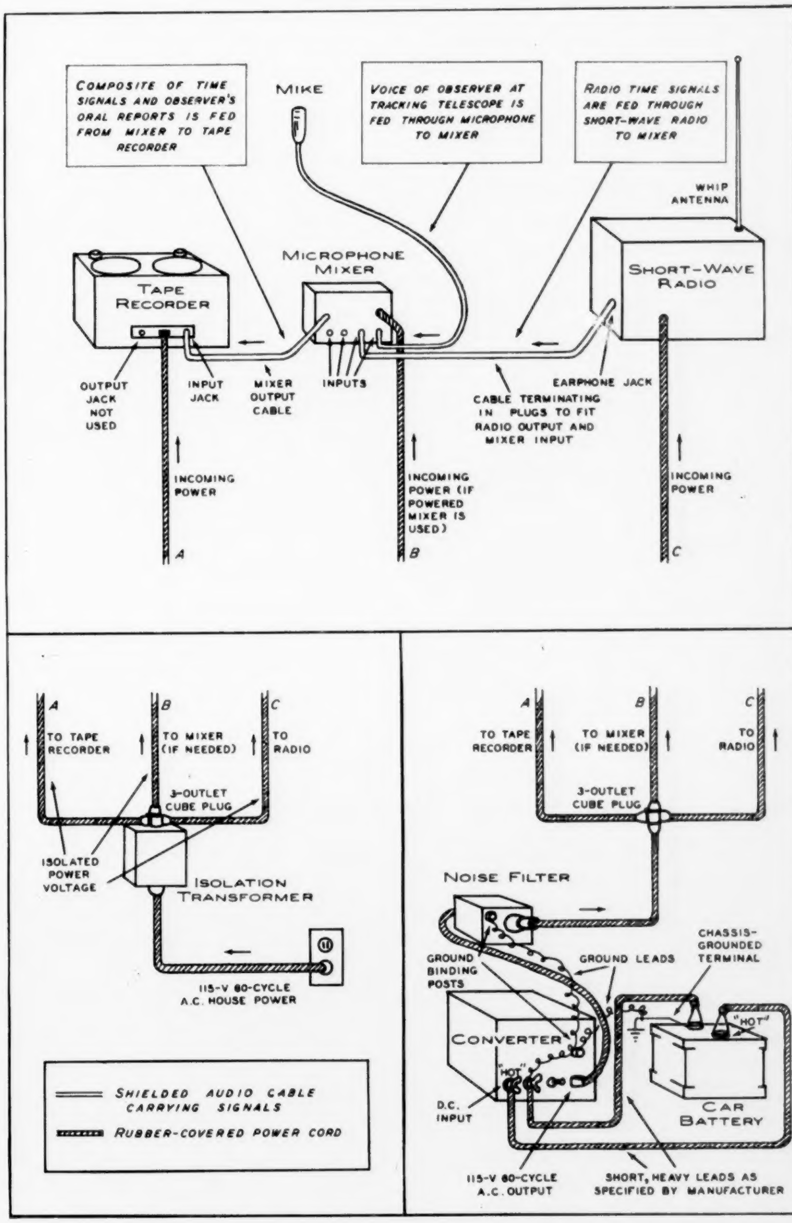
Two general types of mixers are available through radio parts houses. One of these, exemplified by the Pentron Audio Mix shown in the photograph, contains built-in amplifier circuits and requires power voltage for operation. It retails for $47.50, and is capable of amplifying a signal as well as attenuating it, before passing it on to the tape recorder. This model has four high-impedance microphone input jacks, each with its own volume control. The two additional low-impedance jacks are not used in this application.

If the receiver signal strength is sufficient, however, a non-powered mixer can do the job well at a considerable saving in cost. This second type can only attenuate the signal, as it contains no amplifier, and therefore uses no operating power. An example is Allied Radio's Knight Mike Mixer, which retails for $15 and contains three microphone input jacks, each with its own volume control.

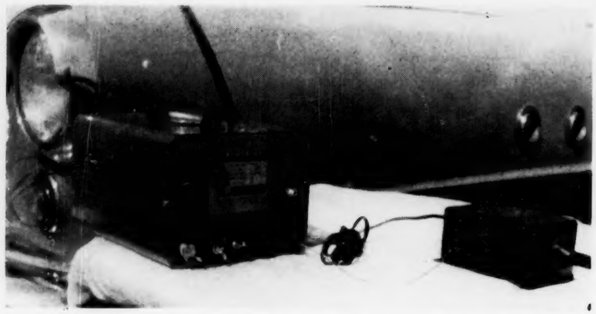
The cable connecting the mike mixer to the recorder is part of the mixer unit and ordinarily plugs directly into the tape recorder. This is true, for instance, if the mixer operates with the Webcor 2711, since the mixer has a phone plug at the end of its output cable and the Webcor has a phone jack at its input. If, on the other hand, the tape recorder input is a pin jack, the mixer output cable will need the Switchcraft model 338 adapter, available through radio parts houses for less than a dollar.

Note especially that there is no impedance-matching problem between the output of a microphone mixer and the input of a tape recorder, as they are immediately adaptable to each other.

*The Microphone.* Instead of plugging the speaking microphone directly into the tape recorder, its output must be fed to one of the channels of the microphone mixer, where it is united with the time signals and sent to the recorder. Impedances match automatically among the microphone, the mixer, and the tape




**The arrangement of the principal components of the system is shown in the upper part of this diagram. At the lower left is the manner of connecting to ordinary house power, using an isolation transformer. Connections to an automobile battery are indicated in the lower right. Note the ground wire to car chassis from one terminal of the battery and from ground binding posts of both the converter and noise filter. The power extension cord from the filter to equipment connections should be at least 10 feet long, to minimize "hash" caused by the converter.**



**Left: The principal apparatus in front of the author's home at Bellwood, the power cord leading upward through the window to a wall outlet. Right: The 12H15 Cornell-Dubilier power converter attached by heavy leads to the car battery.**

recorder, providing a high-impedance microphone is used, which is the normal practice.

In very hot or damp climates, a crystal microphone may slowly deteriorate, in which case a ceramic or dynamic mike should be used, such as Shure Brothers' "Hercules" dynamic model 510C, retailing for $15. A low-cost ceramic microphone is made by Astatic. Either of these models can be used in making up a multiple-microphone system.

*Power Converters.* The power converter, used for other sources of power than conventional house current, must be of sufficient wattage to handle all of the equipment it drives, with some power to spare. An automobile converter will satisfy most requirements best. The 12H15 Cornell-Dubilier pictured here will convert 12 volts d.c. from a car's storage battery to 115-volt 60-cycle a.c. For a 6-volt battery, this manufacturer makes model 6SH15. These and other suitable converters, for d.c. voltages from 6 to 110, range in price up to $120, depending upon their power capabilities.

The Cornell-Dubilier 12H15 is rated at 150 watts, continuous use. This will accommodate the 95-watt Webcor tape recorder, the 20-watt Hallicrafters radio, and the 8-watt Pentron mike mixer, totaling 123 watts. My system, therefore, has a safe margin of 27 watts, which may be used for auxiliary illumination, emergency electrical equipment, or to accommodate any unforeseen overload in the electronic system. This case illustrates the rule of adding up the wattages of all the equipment needed and then choosing a converter to carry a load about 20 per cent over the total wattage.

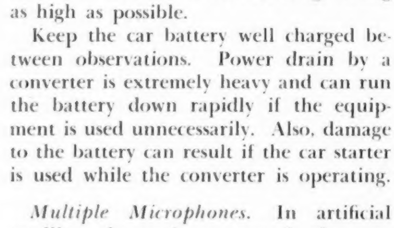
Since converters of the type described are inherently sparking devices, they unavoidably introduce radio noise which is picked up as interference by the receiver. For the sake of clear WWV reception, this interference must be minimized by means of a noise filter. Mine is a Cornell-Dubilier model IF-18, which plugs into the converter at the car. The power cord stretching away from the car should be at least 10 feet long, to deliver filtered current to the electronic components of the system.

The ground binding post on the filter must be connected to the grounded side of the converter and to the chassis of the car. This reduces the interference markedly though not completely, and the WWV signals can normally be distinguished. There is a special circuit within the radio receiver, however, which will lessen interference effects further if there is a strong radio signal in the detector stage. This strong signal may be obtained by tuning WWV very sharply and by providing enough antenna to bring in a clear radio signal. An outside antenna should be from 30 to 60 feet long, strung as high as possible.

Keep the car battery well charged between observations. Power drain by a converter is extremely heavy and can run the battery down rapidly if the equipment is used unnecessarily. Also, damage to the battery can result if the car starter is used while the converter is operating.

*Multiple Microphones.* In artificial satellite observations, several observers must deliver their oral reports to the tape recorder. A Pentron mike mixer already has four high-impedance jacks, as mentioned before; three of these will each accept a microphone connection. The Knight mixer will take two microphone cables in addition to that from the short-wave radio.

Each microphone cable can be extended up to 30 feet without appreciable loss of signal strength. The Webcor model 2929 microphone extension accessory is 15 feet long, fitting the standard phone plug at one end and the phone jack at the other. It sells for $4.50, and two of these may be used in series, with any kind of high-impedance microphone.




**The method of connecting half a dozen microphones into the system, using Minimix units.**

Outdoor tests at Bellwood with my Webcor recorder and Pentron mixer show that, with full gain on both units, the performance of the crystal microphone is good at 20 feet, enough to monitor a 40-foot line of observers. This result is based on normal outdoor conditions, and an airplane flying over at the wrong moment could completely obliterate an observer's report. Better results can be obtained, of course, by connecting three separate microphones into the Pentron mixer, with pairs of observers within five feet of each microphone.

Ideally, each observer should be provided with his own microphone, which can be accomplished with several mixers, as shown in the diagram. Use Minimix model 310 audio mixers, each providing for two microphones; three of these plugged into the Pentron mike mixer will provide for six microphones altogether. This number can be doubled by adding more Minimix units. The Minimix units have a volume control for each channel, and all the controls should be set at maximum while testing or operating the system.

Microphones can be purchased through radio parts houses or tape-recorder dealers. The Webcor crystal microphone ($10) is available separately and is equipped with the right phone plug to fit either the mixer or the recorder.

The sensitivity of a microphone depends on many factors, including the power gain of the amplifier into which it feeds. But there is an upper limit to the power delivered by an amplifying system, and acoustical feedback or "howl" may occur if the tape-recorder gain control is set too high. This effect can be minimized by keeping all microphones as far as possible from the recorder, and adjusting the volume controls on the mixer separately for each microphone, aiming at a clear signal without feedback.

Where the above methods fail, monitor with a pair of earphones. On the Webcor recorder, plug the phones into the output jack, located on the rear panel, while leaving the selector switch at the monitor position. This action cuts off the loudspeaker

of the recorder, thus preventing feedback.

Where multiple microphones are used for satellite teams, each observer should identify a report with his own name. This will avoid confusion on the tape that might otherwise arise from voices with similar characteristics.

*Beware of Shocks.* In all cases, whether using a converter or house current, be careful of voltages between any two components and between the equipment and ground. Select a *dry area only* for the observing station. If possible, wear shoes with heavy rubber soles and heels. A broad, dry wooden board is a good thing to stand on, in any case.

Shock hazard can be reduced by inserting an isolation transformer, shown in the first picture (page 542), between the source of house power and the electronic components. The Chicago Transformer model IS-150 (less than $20) is suitable. These isolation transformers are rated in the same way as converters, to match the total equipment wattage with a safety factor. An isolation transformer is recommended as a worth-while investment against shock hazard.

*Total Expenditure.* Here are the presently known retail prices of the individual components:

| | *Least Cost* | *Average Cost* |
|---|---|---|
| Short-wave radio | $49.95 | $100.00 |
| Tape recorder | 90.00 | 200.00 |
| Microphone mixer | 15.00 | 47.50 |
| Isolation transformer | 20.00 | 20.00 |
| | $174.95 | $367.50 |

Where a power converter and interference filter are to be used, add approximately $80 to both totals, and subtract the $20 cost of the isolation transformer. These units, used on different power systems, are mutually exclusive. Cords, plugs, and special fittings will come to about $10.

*The Time Signals.* WWV provides an identifying Eastern standard time oral announcement every five minutes. This identifies the next five minutes, during which the seconds beats are heard. The start of the first three minutes of each five is indicated by a long dash accompanied by a double click, and by a double click only for the final two minutes, during which the audio tone disappears. A Morse code statement (Universal time) precedes the announcer's voice introducing the next five-minute period.

While making an observation, to fix securely the moment of the spoken signal, the recording must include at least one five-minute identification on the same continuous run of tape. Then, during the playback, the time of the observation is found by counting the seconds beats between the start of that five-minute period and the observer's signal. A second playback should be made as a check on the interpretation of the time signals.

Should the five-minute time announcement preceding the observation be missed for any reason, it is still possible to time the observation by permitting the tape recorder to run to the *following* five-minute identification. Then count the time signals from the moment of observation to the recorded time identification.

The use of recorded WWV time signals eliminates the need for a member of the team to serve as timekeeper, but an operator of the electronic apparatus is needed instead. The timing is automatic, once the system is set in action. The timing device need not be synchronized with anything, as in the case of a stop watch. Events occurring in rapid succession can be timed without visual reference to a timepiece of any sort. With correctly operating equipment, the time signals are practically always recognizable and are independent of the speed of the recorder, either on recording or playback.

*Temporary Radio Silence.* Short-wave radio transmission is affected by ionospheric changes, and the signals from WWV and WWVH are subject to occasional fade-outs. Their duration may be a few seconds or several hours. Furthermore, for certain periods of each hour and day, the signals are regularly interrupted. But these lapses should not appreciably affect the accuracy of the results obtained by the tape recorder method, particularly in timing the artificial satellites.

To provide against loss of its signals due to fading, WWV broadcasts simultaneously on frequencies of 2.5, 5, 10, 15, 20, and 25 megacycles per second. WWVH broadcasts on 5, 10, and 15 megacycles. Receiving sets may tune to the band of optimum signal reception for the period of the observations, or the band may be changed if the selected frequency is subject to serious fade-out.

As for the periodic interruptions, WWV is not heard for four minutes each hour, beginning at 45 minutes after the hour. The signals begin again at about 11 minutes to the following hour. WWVH is interrupted for four minutes twice each hour, starting on the hour and half hour, and for a period of 34 minutes starting at 19:00 UT (8:30 a.m. Hawaiian standard time). Since the observing times for the satellites will be during morning and evening twilight, this 34-minute interruption is of no consequence to observers in Hawaii or the continental United States.

Therefore, for any astronomical observations made during the periodic interruptions of WWV or WWVH, or during temporary fade-outs, keep the tape recorder running continuously until the next five-minute identification that can be properly recorded. When the recording is played back *at the same speed,* the beats can be counted against the time elapsed.

This can be done on the spot by removing the connections of the radio-to-mixer cable *at the radio* (which puts the radio loud-speaker back in operation) and setting the recorder to its playback position. The time signals, now coming audibly from the radio, can be counted as the recording plays from the moment of the observation to the recorded time announcement. Once this interval is determined, the true time of the observation is established by subtraction.

Another method is to use a synchronous electric clock or an accurate watch to count the seconds.

All inquiries concerning technical radio broadcast services of WWV and WWVH may be addressed to Radio Standards Division, National Bureau of Standards, Boulder, Colo.

## *NEUTRINO CONFIRMED*

For more than 20 years, physicists have postulated the existence of neutrinos—uncharged elementary particles of extremely small mass—to explain an apparent violation of the law of conservation of energy. In the spontaneous decay of a neutron into a proton and an electron, the particles formed have less energy than the neutron, and W. Pauli hypothesized that an undiscovered particle carried away the remaining energy. Since then, the same assumption has been required to explain other experiments in nuclear physics.

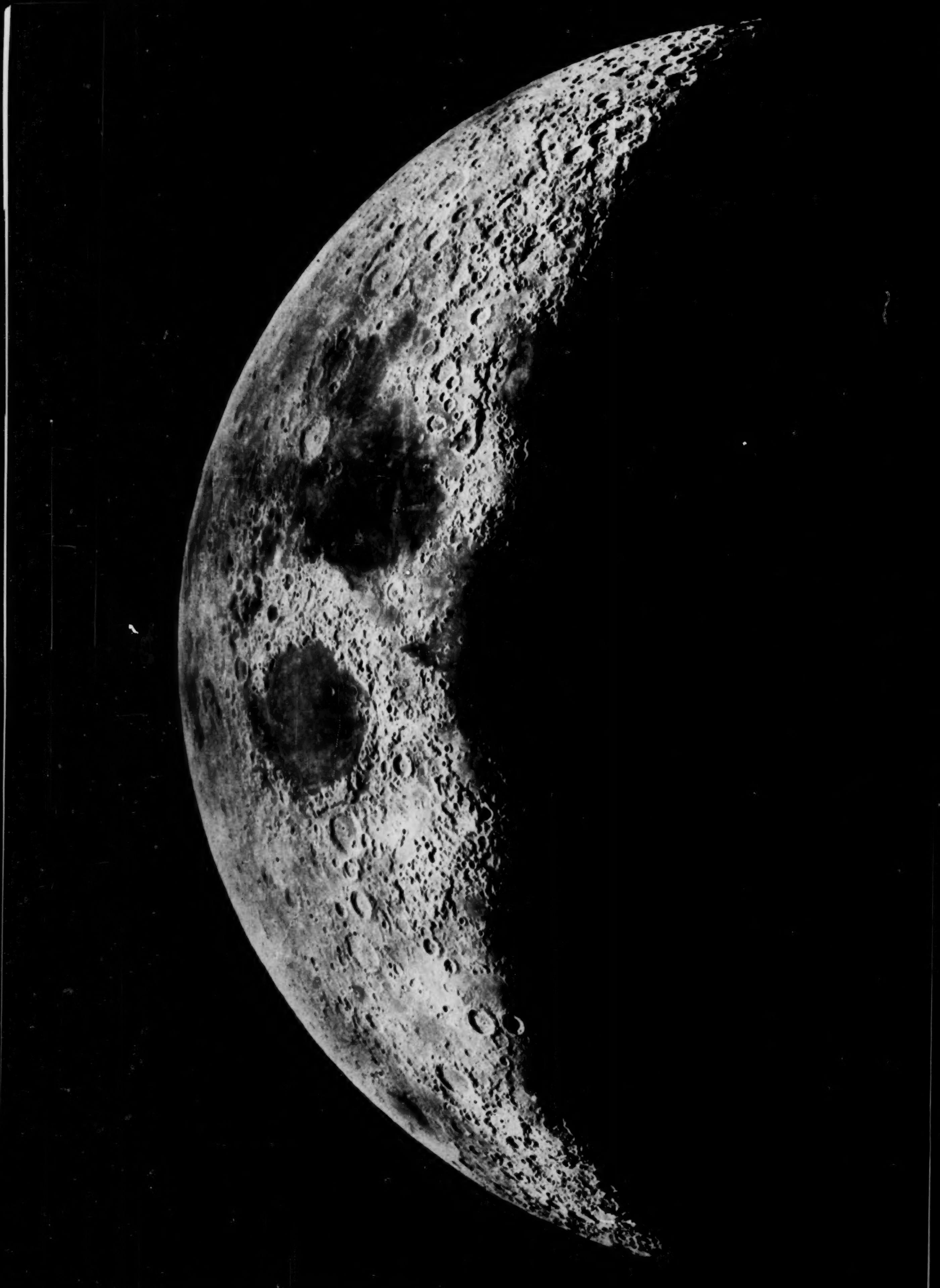
Direct experimental verification of the neutrino involves observing the effects of its collision with another particle. The difficulty lies in the extreme rarity of such collisions: a neutrino can travel through roughly a hundred light-years of solid matter before being captured.

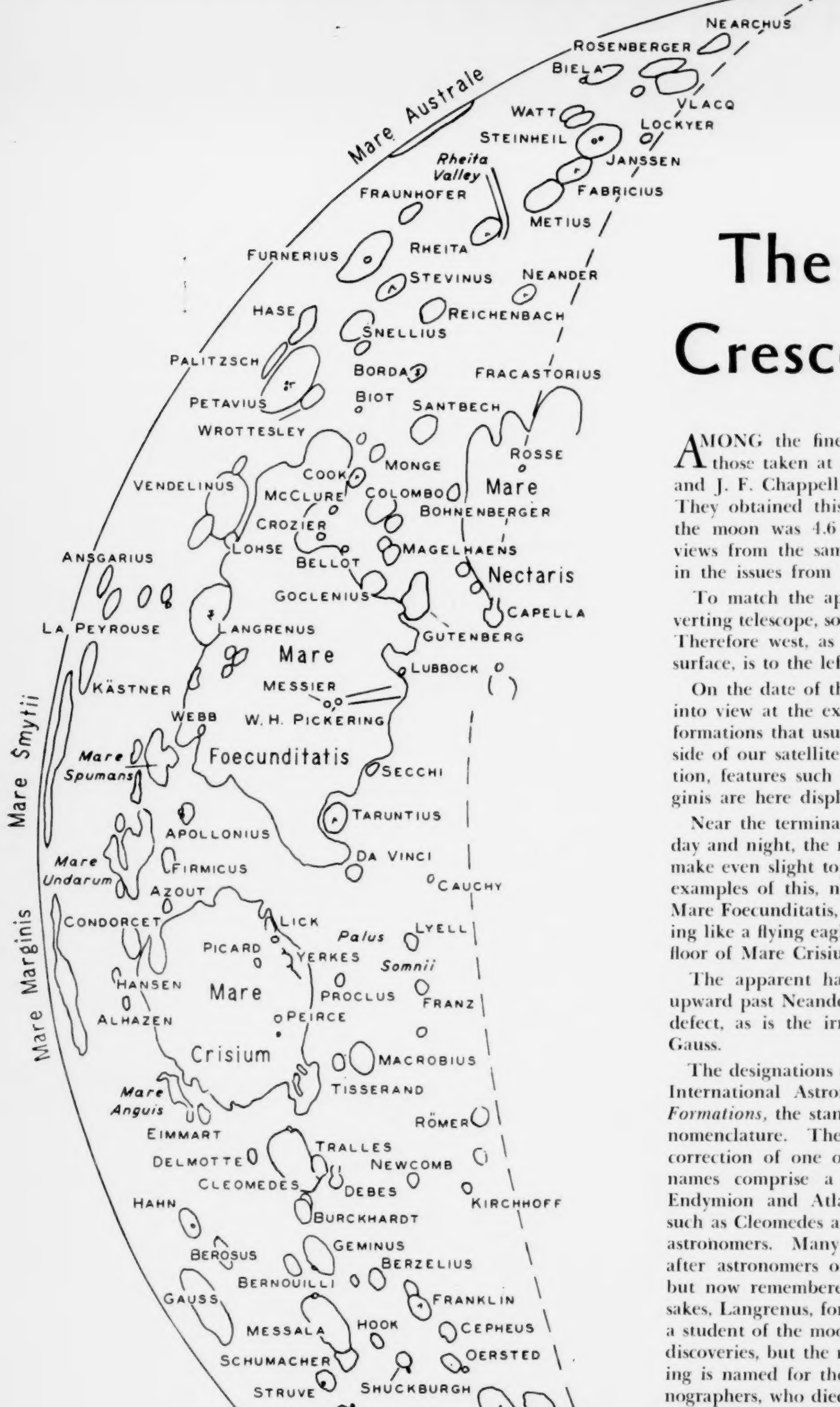
At last, C. L. Cowan, Jr., F. Reines, and their associates have definitely observed neutrinos in the products of the Savannah River, South Carolina, atomic pile of the Atomic Energy Commission. In 1953, these Los Alamos physicists had tentatively identified neutrinos produced by the Hanford reactor.

This striking verification of a theoretical prediction is an achievement similar in many ways to the visual discovery of the planet Neptune, whose existence had been predicted to explain why the motion of Uranus seemingly disobeyed the laws of celestial mechanics.

## *AURORAL REPORTS*

On the morning of September 2nd, an auroral display was seen from as far south as Augusta, Arkansas, by John W. Haralson. He watched it from 2:15 to 3:15 a.m. CST, when the rising moon began to brighten the sky. Although the aurora was not very bright, it was noteworthy for the red color of most of the forms, and a yellow ray, reaching 40 degrees up the northern sky, was seen at 3:02 a.m. On the following night at Chesterfield, N. H., Leo Mattersdorf observed a brilliant bluish-green aurora which extended nearly to the zenith shortly after midnight.






# The Waxing Crescent Moon

AMONG the finest of all lunar photographs are those taken at Lick Observatory by J. H. Moore and J. F. Chappell with the great 36-inch refractor. They obtained this picture on June 2, 1938, when the moon was 4.6 days past new. Four enlarged views from the same negative were feature pictures in the issues from February through May this year.

To match the appearance of the moon in an inverting telescope, south in this photograph is upward. Therefore west, as the term is applied to the lunar surface, is to the left.

On the date of this photograph, libration brought into view at the extreme western edge of the moon formations that usually are out of sight on the other side of our satellite. Because of the favorable libration, features such as Mare Smythii and Mare Marginis are here displayed to unusual advantage.

Near the terminator, the boundary between lunar day and night, the rising sun casts long shadows that make even slight topographic relief conspicuous. As examples of this, note the curious curved ridges in Mare Foecunditatis, and the ruined crater walls, looking like a flying eagle, on the easternmost part of the floor of Mare Crisium.

The apparent haze in Mare Nectaris, extending upward past Neander, is not real but a photographic defect, as is the irregular scratch across the crater Gauss.

The designations on the key chart are those of the International Astronomical Union's *Named Lunar Formations*, the standard authority for selenographic nomenclature. The only departures have been the correction of one or two misspellings. The crater names comprise a curious pantheon. Some, like Endymion and Atlas, are from mythology; others, such as Cleomedes and Firmicus, were ancient Greek astronomers. Many of the largest craters are called after astronomers of the Renaissance, once famous but now remembered chiefly for their crater namesakes, Langrenus, for example. Messier, who was not a student of the moon, is memorialized for his comet discoveries, but the neighboring crater W. H. Pickering is named for the most famous of American selenographers, who died as recently as 1938.

Next month the waning crescent photograph, comprising the feature pictures for June through September, will be reproduced with a similar key. The entire series of 10 plates is scheduled to be reprinted early in 1957 as a companion to Moon Sets.

# *Amateur Astronomers*

## Observing Activities of New York Amateurs

SINCE we made an organizational report concerning the observing group of the Amateur Astronomers Association some three years ago (*Sky and Telescope*, March, 1953, page 126), experience has taught us a great deal. Despite the many handicaps of observing in such a large city as New York, we have achieved several worth-while results.

Our greatest success has been with variable stars. As almost half of our 60 registered observers own 7 x 50 binoculars, there was from the beginning no shortage of modest equipment. Instruction pamphlets were prepared by experienced observers and the necessary charts were obtained from the American Association of Variable Star Observers. After the first year of training, more than a score of active observers were able to contribute sufficiently accurate estimates of brightness.

From a starting program of a few interesting variables, our list has expanded to the limit of available charts and equipment. By the end of the first year, our monthly total of observations was in the hundreds; a year later this had doubled. From September, 1954, to August, 1955, the AAVSO records show that our group made 21,281 estimates, about one third of all that association's observations for the period.

Such a record was compiled in a large city partly because estimating star magnitudes requires only moderate seeing conditions. We publish a monthly bulletin for the observing group, *The Eye-Piece*, which reports the variables observed, the number of estimates, and the names of observers. A competitive spirit was thus stimulated. Nevertheless, we do not expect to make such a large number of estimates in the future, as the first flush of enthusiasm is giving way to a more mature approach. We are becoming rather selective, working on fainter stars whenever telescopes are available. This is a more time-consuming challenge than binocular observations.

One or two very energetic members carry on continuous meteor observing, but most of the group has been active in this field only during favorable meteor showers. Despite the usual percentage of clouded-out nights, field trips to watch the Perseids, Delta Aquarids, and Geminids, from good sites outside the city, have been all-night successes. An auroral display enlivened one such occasion.

Meteor enthusiasts are provided with instruction pamphlets, and by their second outing the counting, timing, and plotting of meteor paths are familiar processes. All our observers are alerted to the importance of recording fireballs and telescopic meteors, these reports being forwarded to the American Meteor Society. The requirements for meteor reports are among the many subjects discussed at our monthly observing group meetings at the Hayden Planetarium.

In lunar and planetary observing, our contributions have been small. Excellent atmospheric conditions and instrumentation are needed to observe the moon for surface colors, minute details, and possible mists and changes. We are deficient in the patience, concentration, and long hours required to develop visual acuity for planetary studies—our city dwellers are too much within the range of telephone and television to be attracted to such work.

But they are interested in knowing about all phases of astronomy, and our achievements with the moon and planets have been in understanding the methods used by observers elsewhere. We have familiarized ourselves with the use of co-longitude in lunar observing and the "controversial" surface features of the moon; we know about the belts, zones, and disturbances on Jupiter, and of the mutual occultations of its satellites; the possibility of a tenuous outer ring of Saturn; the character of the fugitive markings of Venus and the determination of its dichotomy; the now famous W of Mars. Indeed, we have studied a hundred and one odd facts that few of us knew when we first began. We now know how, where, when, and what to look for on the moon and planets as better opportunities arise. This is, therefore, an educational investment which can produce dividends later.

This also holds true for the northern lights. We know what to look for and how to interpret an auroral display. With solar activity on the increase, and with many of our members spending vacation time in New England and upper New York State, we can expect them to make satisfactory records when an aurora borealis appears.

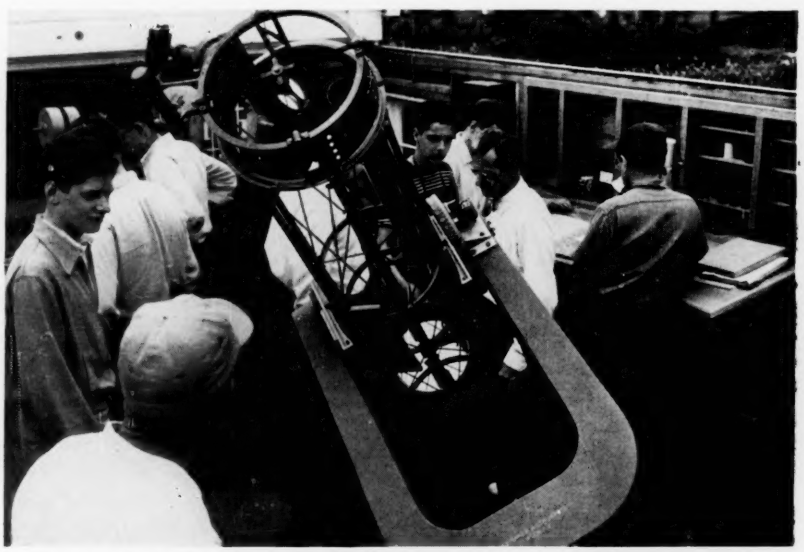
Although lacking long periods of apprenticeship, a few of our members contribute regular observations of sunspots; making drawings of the solar disk without attempting to classify or interpret what they see. This work develops skill and care, and it is of value to the AAVSO Solar Division.

Eclipses, both solar and lunar, have been well covered by our group. "Expedition Blackout" obtained creditable photographs at the June, 1954, total eclipse from an airfield in Michigan (*Sky and Telescope*, September, 1954, page 364, and October, 1954, page 419).

With the International Geophysical Year ahead, we are planning active co-operation in the visual observation of artificial satellites. Equipment is being constructed, detailed assignments worked out, and training programs organized.

Certainly much of the work described in this report might have been done by individuals without the existence of this observing group, but we have given each individual's attempts at observing a stimulus, direction, and purpose. Somewhere along the line of sight we may have collected a bit of information that will be valuable to astronomy in some way, some day. At least, we think it would be difficult to prove that we haven't.

EDGAR M. PAULTON
Chairman, Observing Group
Amateur Astronomers Association
201 W. 79 St., New York 24, N. Y.



**On one of their field trips, members of the observing group of the New York Amateur Astronomers Association inspect the equipment at the observatory of Floyd Houston, New Suffolk, N. Y. Photograph by Charles Cuevas.**

## THIS MONTH'S MEETINGS

**Geneva, Ill.:** Fox Valley Astronomical Society, 8 p.m., City Hall. Oct. 13, V. A. Carpenter, "Magnetism of Sun and Planets."

**Long Beach, Calif.:** Excelsior Telescope Club, 7:30 p.m., home of Alika Herring, 3273 Liberty Ave., South Gate. Oct. 5, Alika Herring, "The 11 Craterlets of Plato."

**New York, N. Y.:** Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Oct. 3, Dr. Fred L. Whipple, Smithsonian Astrophysical Observatory, "Artificial Earth Satellites: Optical Tracking."

**Washington, D. C.:** National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Oct. 6, Dr. James B. Edson, Office of Chief of Ordnance, U. S. Army, "Under a Martian Sky."

## NORTHEAST CONVENTION

Dr. Carl W. Gartlein of Cornell University told the 66 registrants at the Astronomical League's Northeast Region convention that amateurs will be needed to aid professional astronomers in observing the aurora during the International Geophysical Year. Dr. Gartlein was the banquet speaker at the annual meeting, which was held at Colgate University in May.

In his address to the convention, G. R. Wright described the work amateurs could do in the artificial satellite tracking program.

Societies from Corning and Syracuse, N. Y., were represented for the first time at the convention. The Syracuse group had applied for league membership, and the Corning club is expected to join soon.

## ROCKY MOUNTAIN CONVENTION

The second annual conference of the Mountain Astronomical Research Society was held August 4-5 on the University of Denver campus. Registrations numbered 48, while 69 persons attended the banquet.

During registration, Dr. A. W. Recht, director of Chamberlin Observatory, held open house with the 20-inch Clark refractor, showing Venus and Sirius as daylight objects, as well as sunspots. At the afternoon session, E. D. Onstott, Pueblo, Colo., told about the popularization of astronomy in his community, and his son Edward spoke on dynamics. This part of the program was concluded by Roger Gallet, of the National Bureau of Standards, who described his research on radio noise from Jupiter. He asked for visual observations of the planet from regional amateurs to correlate with his radio records.

The banquet speaker that evening was Gordon A. Newkirk, of the High Altitude Observatory, who told about the effects of solar activity on weather.

At the business meeting next morning, the Mountain Astronomical Research Society was formally organized as the parent group for all participating societies. E. D. Onstott was elected chairman; the undersigned, vice-chairman; Marjorie Struthers, Pueblo, secretary; and Jim Johnston, Boulder, treasurer.

At its regular meeting following the conference, the Denver Astronomical Society, hosts at the convention, voted to rejoin the Astronomical League.

KENNETH STEINMETZ
1680 West Hoye Place
Denver 23, Colo.

## WINNIPEG, CANADA

A series of star parties and noon-hour lectures were given at the University of Manitoba campus during the week of July 16-20 by the Royal Astronomical Society of Canada, Winnipeg Centre. Robert J. Lockhart, of the department of mathematics and astronomy, gave the lectures, which drew 450 listeners, many of them teachers attending the university summer school. Despite inclement weather, there were three clear nights for the 1,200 persons who observed through five telescopes at the star parties. Society members and astronomy students assisted.

A 12-week non-credit course in popular astronomy will be offered during the winter by the university's extension service. The course provides the society with a yearly source of new members.

## CLEVELAND, OHIO

A record crowd of 10,000 Clevelanders attended the 28th annual Cleveland *Press* stargazing party at the Warrensville Heights High School on August 14th. Films of the solar system were shown, and the Cleveland Amateur Telescope Makers Club provided 28 instruments for viewing Saturn and Mars. David Dietz, *Press* science editor, and Oscar L. Dustheimer, former professor of astronomy at Baldwin-Wallace College, lectured on heavenly bodies. A second star party was held on August 16th in Lakewood Park.

## NORTH SCITUATE, R. I.

New England amateurs are invited to attend an astronomical get-together on October 6th, sponsored by Skyscrapers, Inc. The meeting will be at the Seagrave Memorial Observatory, Peeptoad Rd., North Scituate, R. I. Registration begins at 1:00 p.m., and will be followed by exhibits, judging of instruments, dinner, evening discussions, and awards of prizes. For further details, write to W. Edwin Stevens, Fiskeville, R. I.

# LETTERS

Sir:

One way to remember the names of the planets in order from the sun is by the "word" M-VEM-J-SUN-(Pluto), as suggested by J. Russell Smith on page 402 of the July issue. Another mnemonic aid which has stuck in my mind for 25 years is the sentence: "Man Very Early Made Jars Serve Useful Needs Perfectly."

My wife found this worked well in teaching a little elementary astronomy to a girl scout troop in Cleveland, but I have forgotten its source.

ROBERT W. WILSON
20 Treasure Drive
Tampa 9, Fla.

Sir:

The two-page picture of the globular cluster in Hercules, M13, published in the June, 1955, issue of *Sky and Telescope* together with a magnitude key, has been very useful in determining how faint a star can be seen with my 8-inch reflector. I made this instrument at the National Capital Astronomers in Washington, D. C.

This summer, on August 9th, a clear, moonless night, I had the telescope at an altitude of 8,000 feet, near Carson Spur, California, in company with Peter Sheehan, of Lodi. The great Hercules cluster was near the zenith, and through the 8-inch a star of magnitude 13.28 appeared as bright as a moon of Saturn, Dione. With averted vision we could clearly see a star of magnitude 15.01, using 173x.

MARC IMLAY
3913 Jeffry St., Silver Spring, Md.

Sir:

In his article in the March, 1956, issue, Patrick Moore strongly criticizes the hypothesis that lunar craters were caused by meteoritic impacts. One of his arguments is that the distribution of craters over the moon does not appear random.

Nevertheless, beautiful moonlike patterns are easily imitated by experiment. The accompanying photograph of a paper

target at which I fired a 410 shotgun shows geometrical figures which convince me that the craters on the moon may be distributed perfectly at random.

ALLAN O. KELLY
Carlsbad, Calif.

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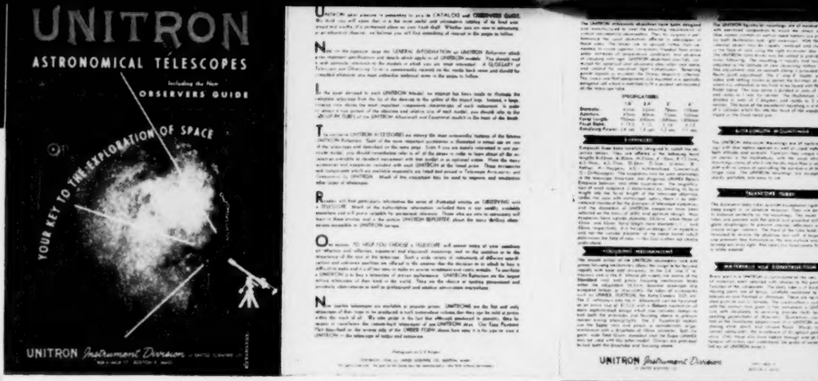



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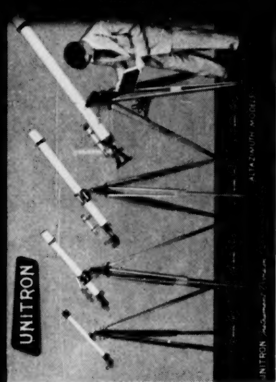
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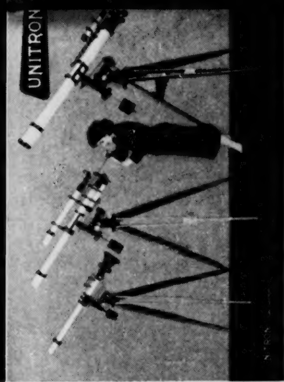
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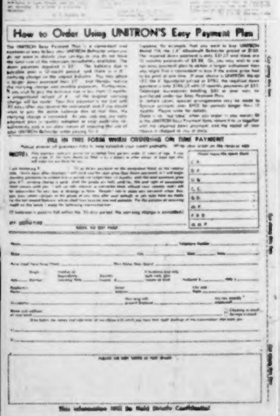
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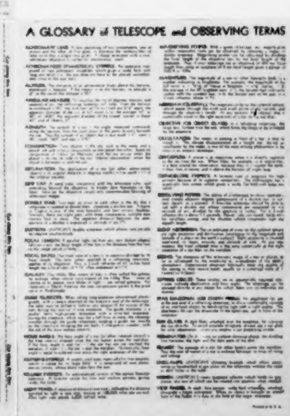
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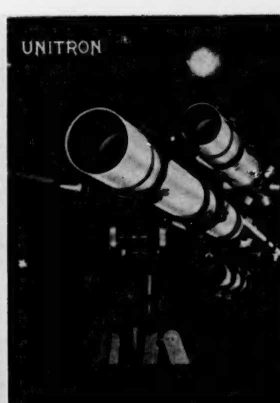
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BULLETIN FOR

# Visual Observers of Satellites

NUMBER 2 60 GARDEN STREET, CAMBRIDGE 38, MASS. OCTOBER, 1956

## NATIONWIDE MOONWATCH ALERT

The MOONWATCH program has now reached the stage at which a nationwide practice session is both desirable and necessary. The first such alert will probably be held between the latter part of November and Christmas, 1956. The exact date is to be announced about two weeks in advance. This will be a full-scale rehearsal, including a communications tryout. Each MOONWATCH station will be expected to report its "results" to Cambridge by radio or telephone.

J. ALLEN HYNEK

## *Concerning International Co-operation:*

In this second bulletin for visual satellite observers, we send greetings to the delegates at the Barcelona conference of the International Geophysical Year (September 10-15, 1956), and through them to all citizens of their respective countries who wish to participate in the IGY artificial satellite program. We take this opportunity to invite amateur astronomers and other active watchers of the sky to share in the visual satellite observing program which was announced in *Bulletin* No. 1 (*Sky and Telescope*, July, 1956). Already, visual observers in the United States have begun the organization of stations for satellite observation.

The visual program has been termed MOONWATCH to distinguish it from the precision photographic satellite tracking, which has been described elsewhere and to which international participation has also been invited. Optical specifications for the precision Schmidt-type tracking cameras were calculated by Dr. James G. Baker, who, as most of you know, was the optical designer of the super-Schmidt meteor cameras used in the Harvard meteor program. The Baker design calls for a modified Schmidt system using a 31-inch spherical mirror and a triple corrector plate. The mechanical features of the tracking cameras, including shutter, timing, and film-transport mechanisms and the satellite tracking drive, have been designed by Joseph Nunn and Associates of Los Angeles. Manufacture of certain parts of these cameras has begun. Pyrex blanks for 12 such mirrors are in production at the Corning Glass Company.

MOONWATCH observers, though not directly participating in the photographic tracking of the satellite, will have much to do with the success of the precision program. The big cameras can go to work effectively only after a preliminary orbit of the artificial satellite has been obtained from visual or radio spottings. Also, in the last stages of the satellite's life, when the rapid changes in its orbit may give valuable information about upper atmosphere densities, the visual observations will be of paramount importance.

The wider and more extensive participation on the part of amateur astronomers and other nonprofessional observers everywhere is now possible because plans for the visual program have made important progress during the summer. All interested persons in other countries should make their desire to take part in this program known to the Smithsonian Astrophysical Observatory *through their respective IGY committees*. It is planned that an authorized coordinator of visual observers will be appointed by the IGY committee in each country.

Dr. Armand Spitz is the coordinator for the United States. He is advised by a national committee of experienced visual observers whose chairman is G. R. Wright. Subject to the discretion of the respective coordinators in other IGY countries, similar advisory committees may be created.

All requests for further information and other communications from foreign participants should be directed through their national coordinators and IGY committees. Essential information on observing procedures will, however, be contained in these bulletins, to be distributed to observers in other countries through these same channels.

As representatives of the secretariat of the International Geophysical Year, we welcome observers everywhere to assist in the satellite program, which offers an unparalleled opportunity for the capable nonprofessional astronomer to make a significant scientific contribution. May we hear from you through your local International Geophysical Year organization.

FRED L. WHIPPLE, Director
Smithsonian Astrophysical Observatory

J. ALLEN HYNEK, Associate Director
In Charge of Satellite Tracking Program

## III. Optical Instruments for MOONWATCH Observers

*A. The Optical System.* The specifications for optical devices must be somewhat flexible, to avoid undue expense to volunteers who are already giving freely of their time and effort. But the telescopes used must conform to certain broad requirements of aperture, size of field, and magnification.

The brightness of the satellite will range from scarcely naked-eye visibility to between 8th and 9th magnitude, averaging about magnitude 7. An instrument with an aperture of about 50 millimeters (two inches) will be needed to show the satellite and its background stars easily.

The magnification must be low enough to provide a wide field, but at the same time utilize the full light-gathering power of the objective. Thus, the instrument's exit pupil (the bright spot seen when the telescope is held away from the eye and pointed to a daytime sky) should not be larger than the pupil of the observer's eye when it is nearly dark-adapted. The diameter of the exit pupil is equal to the aperture divided by the magnification. This condition will be met for a 50-millimeter instrument by a magnifying power of 6x or 7x.

Numerous considerations have dictated that the field of view of a standard MOONWATCH instrument should not be less than 10 degrees. It is clear that a wide-angle eyepiece is a necessity. If, for instance, we use a 60-degree eyepiece and a power of 6x, the field of view will be 60/6 or 10 degrees in diameter.

Therefore, the basic specifications for a suitable MOONWATCH instrument are:

| | |
|---|---|
| Objective diameter | 45 to 55 millimeters |
| Magnifying power | 6x to 7x |
| Field of view | 10 to 12 degrees |

Some observers may already possess large binoculars or monoculars meeting these general specifications. Ordinary binoculars will not suffice, as their field is too small.

Do not trust the rated field, but always make an observational check on each instrument introduced at the station. The two pointer stars of the Big Dipper (α and β Ursae Majoris) are 5.4 degrees apart, and the two stars at the top of the Dipper's bowl (α and δ Ursae Majoris) mark 10.1 degrees. An instrument that does not conveniently accommodate the entire bowl of the Dipper should be avoided; smaller fields would require more observers.

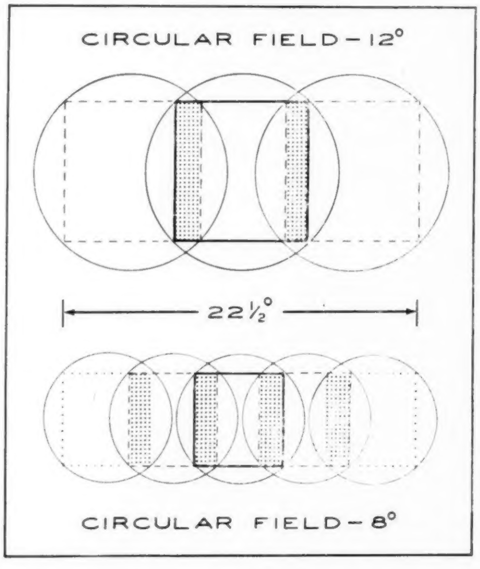
Making a suitable binocular or monocular will be possible for many amateurs, by mounting appropriate lenses and eyepieces obtained from an optical supply house. Prismatic optical systems are not at all necessary. They involve additional expense, and often result in a considerable loss of light.

The choice between monoculars and binoculars is largely a matter of individual preference. Investigations carried out this summer, coupled with the judgment of experienced observers, indicate that a monocular is sufficient, and indeed in some cases is to be preferred to binoculars. Members of MOONWATCH teams may wish to experiment for themselves.

One advantage of a monocular is that when it is used with a plane mirror, as described later in this bulletin, a smaller and therefore less expensive mirror can be employed.

*B. Mounting the Instrument.* Since comfort over extended periods of observation is absolutely essential for the efficiency of MOONWATCH teams, it is recommended that the monocular (or binoculars) be rigidly mounted in a fixed position, in the plane of the meridian, as shown in the accompanying diagram. Attached a few inches in front of the objective should be a small plane mirror of high quality. The telescope-mirror assembly should be adjustable, so the desired portion of the sky along the meridian can be brought into view.

The mirror should be aluminized or silvered on its front surface, like the diagonal flat of a Newtonian reflector, and must be large enough to utilize the entire objective. While the mirror ought to be of optical quality, the relatively low magnification of the satellite tracking telescope will not demand the surface precision of a Newtonian diagonal.




*The chief reason for requiring large fields of view in MOONWATCH instruments is explained here. The circles represent the sky areas visible to adjacent observers, and the square fields have to overlap by an amount taken here as 1½ degrees. Note that, to cover a 22½-degree portion of the meridian, three observers with 12-degree circular fields can do the work of five observers with 8-degree fields. To set up a "meridional fence" 120 degrees long would require about 28 observers with 8-degree fields, but only 17 observers if the fields are each 12 degrees.*

## IV. Layout and Organization of a MOONWATCH Station

*A. The Observing Team.* The basic principle of MOONWATCH station organization is that there be a team of observers, each of whom maintains continuous watch (during the observing interval) of a specified sky area on the celestial meridian. These areas overlap so the satellite cannot cross this "meridional fence" without being detected. This arrangement should be used at least during the first observations for the acquisition of the satellite.

The director of each station, appointed upon recommendation by the advisory committee for visual observers in each country, shall have the responsibility for recruiting and selecting observers. Although it is to be expected that many people will offer their services, the station director must select for his senior observers only those whose experience indicates both reliability and observing skill. Senior observers are those who will man the main north-south or meridional line.

Each person on this line will be assigned one specific area along the celestial meridian for which he will be responsible. A vital requirement is that this observer must not leave his post during the observing session for any reason, no matter how intriguing or exasperating the distraction. Even though another watcher may suddenly call out "There it is!" a senior observer should not quit his own sky area. There is always the possibility of a misidentification, and the real satellite could pass unnoticed if observers do not stay devotedly at their posts.

Alternate observers should be available, if the number in the group permits, to act in the event of unavoidable absences of senior observers, or to spell them if their eyes become fatigued.

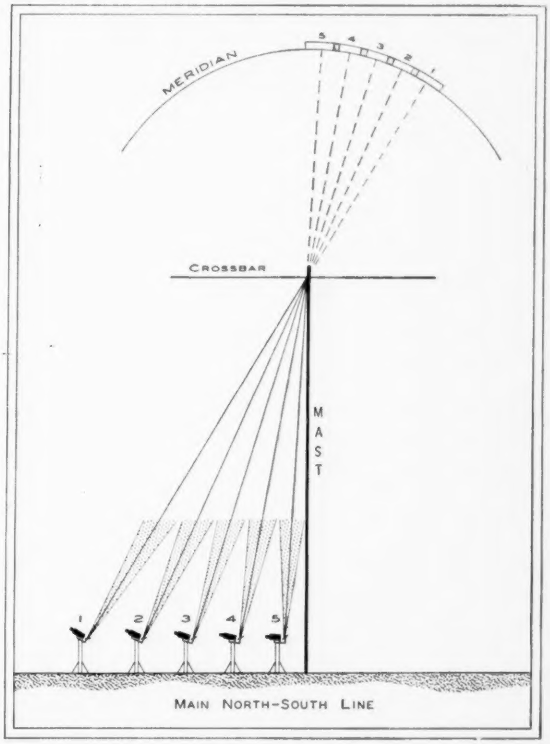
It cannot be emphasized too strongly that looking for the satellite on MOONWATCH teams is a serious task. Orbits will be calculated from the observations that visual observers make, and the usefulness of the large Schmidt stations in various parts of the world may be seriously impaired if some visual observer fails to stay faithfully at his post.

*B. Station Geometry.* The basic requirements to be satisfied are that the entire meridian from a northern to a southern limit, dictated by the latitude of the station, is adequately covered, with suitable overlap, and that the meridian is defined in the field.

The site selected for the station should be reasonably level ground, with an unrestricted view of the northern and southern sky. Freedom from street and house lights is an obvious requirement.

At the center of the observing area, a pole about 25 to 35 feet high may be erected, accurately vertical. This could be a wooden mast or a metal pipe. Perhaps a tall television mast as used in fringe regions may offer an adequate solution in some cases. A thin wire or string with a plumb bob should be suspended from the top of the pole for a check on verticality before the start of observations. The pole is to be fitted with stay wires and turnbuckles, in order to correct any tilt of the pole that may develop.

This pole, with a crossbar at or near the top, can serve as a meridian marker for observers spaced along the main north-south line, which passes through it. Especially for twilight and nighttime adjustments, two small lights can be mounted on the pole at the proper height, one on the north side and the other on the south. The observer can then accurately align his instrument by tilting it until the light appears in the exact center of his field. Of course, these lights will be out during actual observations.




*When the observing instruments are set up along the main north-south line of the station, each one will be oriented by means of the junction of the mast and the crossbar. The upper part of the diagram shows how the respective 12-degree fields overlap on the celestial meridian.*

The particular spacing of observers along the north-south line shall be decided by the station director, in accordance with the effective fields of the instruments used, which will determine the minimum number of observers required for full meridional coverage with adequate overlap. The pattern of positions can be conveniently marked by pegs in the ground if permanent observing piers are not used.

The criterion for spacing MOONWATCH observers should be the *square field* of each instrument, specifically, the side of the square inscribed in the circular field. The length of this side is 0.707 times the diameter of the field. Thus, to obtain an 8-degree

square field, the instrument must have a circular field of about 11 degrees. The station director, in placing his observers, should arrange to have the successive square fields along the meridian overlap by one or two degrees.

Project MOONWATCH welcomes inventiveness as long as the fundamental requirements are covered. We wish to encourage the greatest degree of scientific initiative consistent with the success of the visual program. Hence, the statements above concerning station layout and geometry should be regarded only as recommended procedures to gain a particular purpose. A station director may wish to dispense with the central pole, if his observers use adequate reticles in the observing instruments, and if the latter are properly oriented. Authorized representatives of the advisory committee in each country will decide whether or not a particular station adequately satisfies the requirements.

*C. Setting up the North-South Line.* Regardless of what modifications in observing methods may be adopted by the station director, a north-south line along which the observers are placed is essential. The most direct method of finding this line is to note the shadow of the pole at the instant of local apparent noon, when the sun is on the meridian of your station.

To predict what your watch or clock should read when the sun is actually on the meridian, two corrections must be applied to 12:00:00 apparent local time to convert it to the desired standard time. The first is the equation of time, to be applied with its sign reversed. The second is the longitude correction. If your observing station is *west* of the standard meridian of your time zone, *add* four minutes of time for each degree of longitude difference, and four seconds of time for each minute of arc longitude difference; if *east*, this correction is *subtracted*.

Example: Suppose we wish to lay out the north-south line at a MOONWATCH station in longitude 76° 18′ west, by observing the central pole's shadow on December 1, 1956. For the time of observation, the equation of time is $+10^m\ 47^s$, according to page 16 of the *American Ephemeris*. Also, the observing station is 1° 18′ west of the 75th meridian, the standard meridian for Eastern standard time, corresponding to $+5^m\ 12^s$. Then,

12:00:00 − 00:10:47 + 00:05:12 = 11:54:25.

Therefore, we watch the course of the shadow and at 11:54:25 a.m. EST mark its position. This mark and the central pole define the north-south line.

There are, of course, other more accurate methods by which the trained astronomer or surveyor can obtain a north-south line.

*D. Timing Equipment.* It is expected that each station will be equipped with a radio receiver to obtain precision time signals, and adequate means for recording this time. Again, there is a considerable scope for ingenuity and inventiveness, provided that the passage of the satellite across the central line of a given field is recorded to a fraction of a second.

For instance, if a magnetic tape recorder is available, short-wave time signals and the voices of the observers can be recorded directly on tape, giving a permanent record. If this method is used at a station, it is very important that each observer can be adequately recorded, perhaps by means of an individual lapel microphone.

A detailed description of a tape recorder system for timing astronomical observations is given by M. Francis in the October issue of *Sky and Telescope*.

## V. Position Recording of the Satellite

The position of the satellite in the sky can be determined with good accuracy by simple visual observation, when proper care is taken.

The essential data required from the main-line observers are the time and altitude of the satellite's passage across the meridian. This time can be obtained by carefully noting the instant the satellite is occulted or blocked out by the meridian pole. In addition, a calm and experienced observer can note the position angle of its track. It would be well to alert instantly the two observers who have the adjoining areas under watch, but this should not be allowed to interfere with recording the time, which has top priority.

The most accurate means of finding the meridian altitude is to have the observer plot, immediately after the passage of the satellite, its track in the field of background stars, if any are visible. Since each observer is responsible only for a narrow belt of declination he can prepare in advance a star chart for his zone. On this can be marked for any given day the transit times of successive stars. For example, if the observer has timed the passage of the satellite at 5:22:37 a.m., he can at once refer to the appropriate field on his chart and trace the path of the satellite from immediate memory. This must be done before the observer is distracted by anything whatsoever.

SMITHSONIAN ASTROPHYSICAL OBSERVATORY
I.G.Y. Satellite Optical Tracking Program

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# BOOKS AND THE SKY

### ASTRONOMIE POPULAIRE

**Camille Flammarion.** Completely revised by Gabrielle Camille Flammarion and André Danjon. Observatoire de Juvisy, Seine-et-Oise, France, 1955. 609 pages. About $15.00.

CAMILLE FLAMMARION seems the most influential popularizer of astronomy who ever lived, and his *Astronomie Populaire* was a great success from its first appearance in 1879. When its author died in 1925, over 130,000 copies had been sold in France alone, and there were numerous translations into other languages. Now it has been completely revised and greatly enlarged in a magnificent edition which will make many English-speaking people wish they could read French.

There are over 800 illustrations in *Astronomie Populaire*, mostly photographs, many full page. Readers who think that almost all good astronomical pictures come from American observatories will be surprised. It is refreshing to see the fine photographs from the French observatories: Pic du Midi, Haute Provence, Meudon, Paris, and Flammarion's own observatory at Juvisy. For example, one Paris series shows the striking changes in appearance of the lunar crater Flammarion as the sun rises higher above it: another sequence, by Mme. d'Azambuja at Meudon, shows a prominence at the sun's limb assume the appearance of a dark filament on the solar disk.

The many color plates include a spectacular sequence of the midnight sun. Unfortunately, some of the colored drawings of Mars, Jupiter, and Saturn are unrealistically gaudy. Generally, the numerous line drawings are appropriate and admirably executed. The charts include a full-page map of the moon, and, at the back, two large colored fold-out maps of the sky. I believe the book would have a wider appeal, however, if these charts carried the standard Latin designations instead of French translations of constellation names and lunar features.

More than threescore tables scattered through the book contain information ranging from lists of catalogues of variable stars to the orbital elements of periodic comets. Useful solar-system data fill four pages at the back.

The excellent text is the heart of the book. Much praise must go to Camille Flammarion himself, whose maxim was "Science must be popularized without cheapening it," and whose original 1879 edition gave the framework to the present version. But much credit must be given to Mme. Flammarion, Dr. Danjon, and their collaborators, who have in this revision "introduced the astonishing discoveries of our contemporary science and a picture of the sidereal universe of such grandeur that even the broad imagination of Flammarion himself could never have dreamed of it."

The book is divided into seven major sections. In the first, Dr. Danjon skillfully treats the motions of the earth, from its simple rotation to the slow perturbations of its orbit by the other planets. An unusual diagram shows that the center of gravity of the solar system frequently lies outside the sun. There is a short discussion of the origin of the earth, and some simple geology and paleontology are introduced here—subjects that should be mentioned by astronomy textbooks in this appropriate connection.

The second section devotes 70 pages to the moon, while the third is Raymond Michard's well-organized and up-to-date discussion of the sun. Nuclear reactions in the solar interior and radio emission from the sun are among the "astonishing discoveries" undreamed of in 1879.

A fairly detailed presentation of each planet appears in the fourth section, notable because of its many photographs. There are no less than 50 individual views of Mars. However, one diagram that purports to show the orbit of the asteroid Hermes actually portrays that of Icarus.

"Comets, Meteors, and Meteorites" con-

stitutes the next part. Surprisingly, almost as much space is devoted to these as to the planets, largely because of the abundant historical information about comets. On the other hand, some important recent work on meteors is not brought out clearly.

The book concludes with Charles Fehrenbach's section on the sidereal universe, and a brief account of astronomical telescopes. The well-balanced and well-illustrated description contains many more of the remarkable advances our century has seen: radio astronomy, the spiral form of our galaxy, the expanding universe, to name a few.

But the book as a whole neglects the sidereal universe in comparison with the solar system, giving the former only half as much space. You can learn what the obliquity of the ecliptic will be in 1990 or the names of the Trojan asteroids, but you cannot find anything here about the local family of galaxies or the Stebbins-Whitford effect. This would be a valid criticism of a textbook, but perhaps not of a book for a popular audience.

Popularization begins with simplification. Difficult concepts must be reduced to simple ideas or analogies, but oversimplification can lead to inaccurate statements. This danger is avoided by the capable authors, and such misstatements as "all the epicycles became useless [in the Copernican system]" are rare.

Selection of material provides another means of simplification. But in discussing the origin of the solar system, the authors do not mention angular momentum or the historical collision hypotheses. In describing the formation of lunar craters almost nothing is said about volcanic theories. This type of elimination may make the solution of a problem appear too certain and too final. But such impressions are overwhelmed by the general attractiveness of this book.

OWEN GINGERICH
American University
Beirut, Lebanon

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### A GALLERY OF SCIENTISTS

**Rufus Suter.** Vantage Press, New York, 1956. 132 pages. $3.00.

"THE purpose of these word sketches of ten scientists is to entertain," the author states at the beginning of his preface. The book is not only entertaining but highly stimulating intellectually. Moreover, it raises more questions than it solves, and leaves the endless frontier of science with ever-receding boundaries.

The scientists selected for biographical treatment and interpretation are: Aristotle, Anselm, William Gilbert, Francis Bacon, René Descartes, Galileo, Pascal, Hume, Watt, and Kant. Additional chapters deal with science in China and with medieval logic.

Although a book of essays dealing with such a diverse gallery of scientists perforce lacks unity, the author in his final two pages reaches three conclusions that I have summarized as follows:

1. Science did not develop in societies where interest was concentrated on ethical theory, the state, or on practical interests. Rather, it sprang up where impractical curiosity and a sense of impersonal abstract uniformity prevailed.

2. The empirical attitude of the skilled mechanic was important for the development of modern science.

3. Three competing interpretations of what science is "all about" have arisen:
   a. It concerns the universe of matter, energy, and knowing minds.
   b. It concerns sense data.
   c. It concerns God.

Of course one may not necessarily agree with some of the author's specific judgments or interpretations. For example, on page 22 he seems to subscribe to the old view that astrology preceded astronomy, whereas Sarton and others have held the reverse to be the case. Nor does the author, in commenting on the fact that modern science grew out of a background of medieval Europe, stress the importance of the science of the medieval Moslem world.

The essay on Aristotle brings out the idea that system is as essential to science as observation and experiment. The Greek Peripatetics reached the conclusion that the world is orderly. Centuries of logic-chopping inspired by "the Phil-

osopher" made the idea of an orderly universe become deeply imbedded in the Western mind. Once some of the laws of nature were exposed, modern technology became possible. If the book had appeared a few months later, the author might have pointed out that Einstein in his final posthumous work on relativity argued for a universe of law and order.

It is hoped that these essays, written by Mr. Suter for recreation, will be widely read for the insight they show into questions of perennial importance.

RALPH S. BATES
State Teachers College
Bridgewater, Mass.

### THE EXPLORATION OF MARS

**Willy Ley** and **Wernher von Braun.** Viking Press, New York, 1956. 176 pages. $4.95.

THIS strikingly illustrated volume for armchair astronomers and astronauts is actually two books in one. In the first half Willy Ley tells about Martian observations, as well as the interpretations and controversies they have stimulated. The last four chapters are Wernher von Braun's detailed account of plans for space flight, and the reader is taken on an imaginary expedition to the red planet.

As a popularizer of science Ley has few equals, because of his ability to digest an enormous body of the most varied information on his subject and then give the reader a lively and accurate survey in excellent perspective. Thus he presents the highlights of Martian observations from Fontana's first crude sketch of 1636, through the times of Herschel, Schiaparelli, and Lowell, down to the enigmatic light flashes recorded by contemporary Japanese observers. We are told something about the controversies over the habitability of Mars; noteworthy is the well-informed explanation of why Lowell's "intelligent Martians" fell into general disfavor. Accompanying these discussions are drawings, maps, and photographs of Mars in profusion, showing three centuries of observational advance.

So vividly does Wernher von Braun describe space flight that it is easy to forget than no interplanetary travelers have yet set out on their lonely journey, and even the first unmanned artificial satellite is still to be launched. This is no science fiction, however. Dr. von Braun restricts himself to engineering developments based on present scientific knowledge, avoiding speculations depending on hoped-for future discoveries. While admitting that his present designs may be a far cry from the actual space craft of the future, he maintains that they prove the fundamental feasibility of space travel.

The expedition to Mars described in this book is a revision of Dr. von Braun's earlier plan, described in *The Mars Project* (1953). Although the basic assumptions as to rocket engine performance

have not been altered, the new over-all plan calls for only one tenth the propellant consumption that had been supposed necessary in the earlier proposal. The narrative of the 520-day round trip to Mars is vivid and fast-moving, and its air of realism is heightened by nearly two dozen meticulously detailed imaginative drawings and paintings by Chesley Bonestell. J. A.



## THE WORLD OF ATOMS

**J. J. G. McCue.** Ronald Press, New York, 1956. 659 pages. $6.50.

THERE ARE, perhaps, two major criticisms that may be made of present-day education in the physical sciences. The first is that the student seldom has any idea of what physical equipment is available for gathering information; even worse, he often expects the impossible from the machine shop or the glassblower. The second, more serious, criticism is that the average undergraduate gains little real understanding of either the methods or philosophy of the physical sciences.

The first point may be remedied without too much difficulty, and many colleges now require a special laboratory course to familiarize students with modern experimental equipment and its limitations. The other is not so easily dealt with. Schools offer excellent courses on the methods and philosophy of science, but these are generally taught by the philosophy department, where few chemistry or physics students penetrate.

J. J. G. McCue has supplied a book that may prove to be a partial answer to this problem. *The World of Atoms* gives insight into the spirit of science through a study of the atomic nature of matter. The result is neither a first book in physics nor in chemistry, but an introduction to the whole field of physical sciences.

The book begins with a general survey of early Greek science, and proceeds to develop the notions of mechanics. The subject of heat follows, and then chemistry is introduced. Assisted by the chemist Kenneth W. Sherk, the author discusses the concept of the atom and describes chemical reactions. Electricity and magnetism are next dealt with, preparatory to understanding solutions and their properties. Atoms are discussed in sections on elements, atomic structure, and chemical binding. There is finally a consideration of the atomic nucleus, the great field of 20th-century physics.

Both in style and format, the book is commendable. It is first and foremost a textbook, and a good one, with many useful pedagogical devices. The amateur astronomer will find much of value, for many examples of astronomical work are cited to show the development of the physical sciences.

WILLIAM E. SHAWCROSS
University of North Carolina

## NEW BOOKS RECEIVED

DAS ZEISS-PLANETARIUM, *Heinz Letsch*, 1955, *Gustav Fischer Verlag*, Villengang 2, Jena, East Germany. 136 pages. DM 4.

Persons concerned with the building or use of planetariums, or who are connected with science museums, will find much useful information in this book. It contains a concise account of the astronomical principles of the planetarium, a detailed description of the large Zeiss instruments and of the accessories for special effects, and information about each of the 29 Zeiss planetariums throughout the world. Two additional installations are said to be under construction, at Prague and Peiping.

This book, in the German language, is the fourth edition of a work that originally appeared in 1949. Its 113 illustrations include numerous diagrams of planetarium components and photographs of the exteriors of planetarium buildings.

THE STRUCTURE OF TURBULENT SHEAR FLOW, *A. A. Townsend*, 1956, *Cambridge University Press*, New York. 315 pages. $7.50.

Turbulent motions in gases play an important part in recent investigations of meteors, the sun, and interstellar gas. The astrophysicist specializing in one of these fields should find this book of value.

THE STARS BY CLOCK AND FIST, *Henry M. Neely*, 1956, *Viking*. 192 pages. $4.00.

Mr. Neely is a lecturer at New York's Hayden Planetarium, who has devised a simple method for teaching the constellations and star identification, based on the diagrams, tables, and star charts in this book.

GASEOUS NEBULAE, *L. H. Aller*, 1956, *Wiley*. 322 pages. $11.00.

Writing both as an observer and a theoretical astrophysicist, Dr. Aller summarizes the known facts about the gaseous nebulae and their interpretation, for the professional astronomer and the advanced student. This is the third volume in the *International Astrophysics Series*.

EXPLORING MARS, *Roy A. Gallant*, 1956, *Garden City*. 62 pages. $2.00.

Intended for young people, this lively account of the red planet ranges from the observations of Tycho through Lowell and lichens to space travel. There are imaginative color illustrations by Lowell Hess.

ERGEBNISSE UND PROBLEME DER SONNENFORSCHUNG, *M. Waldmeier*, 1955, *Geest und Portig K.-G.*, Sternwartenstrasse 8, Leipzig Cl, East Germany. 389 pages. DM 38.

*Results and Problems of Solar Investigation* is the second edition of a work that first appeared in 1941. Written by the director of the Zurich Observatory, it is a comprehensive summary of solar astronomy in the German language. While not written for popular reading, it is intended for a broader circle than solar specialists alone.

## Achromatic Astronomical Telescope Objectives

***Real Quality at Bargain Prices Make Wonderful Refractors***

For three years we checked U.S., German, and Japanese manufacturers looking for one who could produce really good telescope objectives at a low price. A few times we ordered samples, only to be disappointed in quality or final price. Finally, we found a Japanese optical engineer who designed some excellent astronomical objectives. We place orders with him. He then has these made, checking each one for quality. Thus, we are able to offer objectives we believe to be as good as those selling for two or three times our price.

Our 3" and 4" diameter objectives are air-spaced achromats, as air-spacing gives the lens designer four surfaces with which to correct aberrations, instead of only three as in a cemented achromat. The results are a beautiful, color-free image, sharp, clear, with very flat field, and no bad zones, and full correction against coma.

| Stock No. | Diam. | F.L. | Price | Comments |
|---|---|---|---|---|
| 30,166-Y | 3" | 45" | $28.00 | Not coated |
| 30,190-Y | 3" | 45" | 32.00 | Coated |
| 50,106-Y | 4" | 60" | 60.00 | Not coated |
| 50,107-Y | 4" | 60" | 69.00 | Coated on four surfaces |

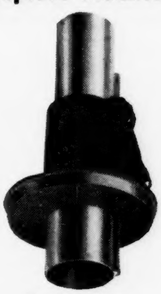
Metal cells are available for the objectives above.

**Stock #70,063-Y**..........$11.95 for 4" objective
**Stock #70,064-Y**..........$10.95 for 3" objective

LOW COST, LONG F.L. ACHROMAT
**Stock #30,187-Y 50" F.L., 2" diam., coated** $12.50 ppd.

## Rack & Pinion Eyepiece Mounts

**For Reflectors**



**For Refractors**

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard $1\frac{1}{4}$" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our $2\frac{7}{8}$" I.D. and our $3\frac{7}{8}$" I.D. aluminum tubes respectively.

**Stock #50,077-Y (less diagonal holder) $9.95 ppd.**
**Stock #60,035-Y (diagonal holder only) 1.00 ppd.**
**Stock #50,103-Y (for $2\frac{7}{8}$" I.D. tubing) 12.95 ppd.**
**Stock #50,108-Y (for $3\frac{7}{8}$" I.D. tubing) 13.95 ppd.**

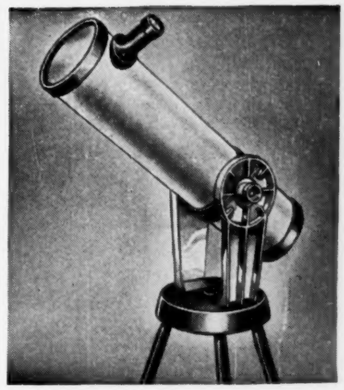
## HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

**HUYGENS TYPE — STANDARD $1\frac{1}{4}$" DIAM.**
**6 mm. ($\frac{1}{4}$") Focal Length**
**Stock #30,063-Y** .......... **$8.50 ppd.**
**12.5 mm. ($\frac{1}{2}$") Focal Length**
**Stock #30,064-Y** .......... **$8.00 ppd.**
**COMBINATION EYEPIECE — 10 mm. and 20 mm.**
**Stock #30,065-Y** .......... **$9.00 ppd.**

# SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope — by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows Saturn, Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36" high on removable legs. Adjustable 3" polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle—swings to any location in the sky. Fascinating 18-page instruction book is included. Instrument packed in sturdy carrying case.



**Stock #70,068-Y** .......... **$14.95 ppd.**

## DOUBLE AND TRIPLE YOUR TELESCOPE POWER

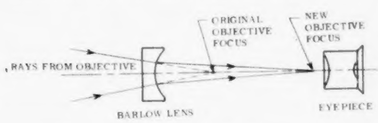
**WHAT IS A BARLOW?**

A Barlow lens is a negative lens used to increase the magnifying power of telescopes by increasing the effective focal length of the telescope objective, but adding little to the physical length of your telescope.

**HOW A BARLOW LENS WORKS**

The Barlow lens, when placed inside the focus of the telescope's objective (either mirror type or lens type), spreads the rays of light coming from the objective and refocuses them to a point a little farther towards the eyepiece, thus increasing the effective focal length of the telescope's objective. See the diagram.

The ratio between the distance the Barlow lens is placed inside the focus of the objective and the distance the eyepiece is away from it determines the increase in power. For instance, if you place the Barlow lens 1 inch inside the focus of the objective, and the eyepiece 3 inches away from the Barlow, power will be 3 times that without the Barlow. Or, you can place the Barlow lens $\frac{1}{2}$ inch inside the focus and the eyepiece $1\frac{1}{2}$ inches away and still get triple the normal magnification, with a more compact system.




**BENEFITS OF A BARLOW LENS**

1. By using a medium-power eyepiece and a Barlow lens you can eliminate short focal length eyepieces and still get high power.
2. REDUCE THE SIZE OF THE DIAGONAL ON NEWTONIAN TYPE TELESCOPES. As a narrower cone of light is used by the Barlow system, you can reduce troublesome diffraction by installing a smaller diagonal.
3. INCREASE THE EYE RELIEF. Short focal length eyepieces have little usable eye relief. A Barlow lens increases the eye relief on any eyepiece used in conjunction with it.

Our mounted Barlow lens is easy to use. Just remove your $1\frac{1}{4}$" diameter eyepiece, slide our mounted Barlow into your eyepiece holder. Then slide your eyepiece into our Barlow tube. Focus and you are ready to see at greatly increased magnification! You can change the power by moving our special variable retaining rings in the Barlow tube. It is really easy and simple, and as long as you have a good mirror or objective lens the Edscorp Barlow lens will give you excellent results.

We have had this lens tested by a number of telescope experts and the reports are all the same — "Excellent" — "Does a remarkable job" — "I would recommend it highly:"

So sure are we of the quality of this lens and the excellent performance that it will give you that we make this **free trial offer:** Purchase our mounted Barlow lens. **Try it for 30 days.** Then if you are not satisfied for any reason just return it to us and we will refund your full purchase price.

**Stock #30,200-Y—Barlow lens mounted in chrome plated brass tubing** .......... **$8.00 ppd.**

## "MAKE-YOUR-OWN" $4\frac{1}{4}$" MIRROR KIT

The same fine mirror as used in our Palomar, Jr., polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

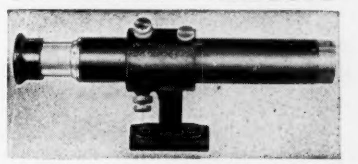
**Stock #50,074-Y** .......... **$16.25 ppd.**

## SPITZ SCHOOL PLANETARIUM

Now — the fundamentals of astronomy demonstrated quickly, easily, VISUALLY! Big planetarium performance. You get a first-hand view of the universe, learn how to identify stars and constellations. Motorized gear automatically turns the projection dome to complete one full day of the heavens in 4 minutes. Projection dome cover is 10 ft. in diameter. Supports made of aluminum. Adjustable horizon height to about 6' 3". Arrow pointer, meridian projector, dome illuminator, sunrise-sunset attachments are all included as accessory items. Operates on 110 volts a.c. A complete set of suggested lecture procedures supplied with each unit. Order by stock number. Send check or money order—money back guarantee.

**Stock #85,035-Y** .......... **$225.00 f.o.b. Phila.**
(Gross weight approximately 70 lbs.)

## 5X FINDER TELESCOPE



Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than $\frac{1}{2}$ pound.

**Stock #50,121-Y** .......... **$8.00 ppd.**

## MISCELLANEOUS ITEMS

**KELLNER EYEPIECE** — 2" focal length ($1\frac{1}{4}$" O.D.). Mount of black anodized aluminum.

**Stock #30,189-Y** .......... **$6.00 ppd.**

**60° SPECTROMETER PRISM** — Polished surfaces 18 mm. x 30 mm. — flat to $\frac{1}{2}$ wave length.

**Stock #30,143-Y** .......... **$8.25 ppd.**

**BE SURE TO GET FREE CATALOG "Y"**
Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

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# GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

## Figuring and Testing a Schmidt Correcting Plate

In planning and constructing an f/3.2 Schmidt camera of 6-inch aperture, I found the comprehensive article by Henry E. Paul in *Amateur Telescope Making—Book Three* of particular value. From somewhere in my reading came the suggestion that the correcting plate could be tested by interference against a flat. A short calculation showed that such a method should be usable and I proceeded on this basis.

The pyrex primary mirror is 10 inches in aperture and of 19-inch focal length. It was worked face up, and all corrections were made on the machine using a full-sized tool. This mirror is spherical within the limits of sensitivity of the Foucault, Ronchi, and eyepiece tests.

The glass for the correcting plate, as received, was slightly more than 7" in diameter, 3/8" thick, roughly circular, and free from striae. Using conventional methods it was ground truly circular, thinned to 0.28", and both faces were worked plane to 1/8 wave and plane-parallel to 0.0001". All working was face up, with the plate floating on a 6" glass disk whose upper face was flat to ½ wave. Dr. Paul recommends using merely an oil film between plate and support, but I found this caused scratching. Therefore I compromised by inserting a 6" circle of oil-saturated good-quality writing paper between the two pieces of glass. Olive oil is superior to heavy mineral oil, mainly because of its easy removal with soap and water.

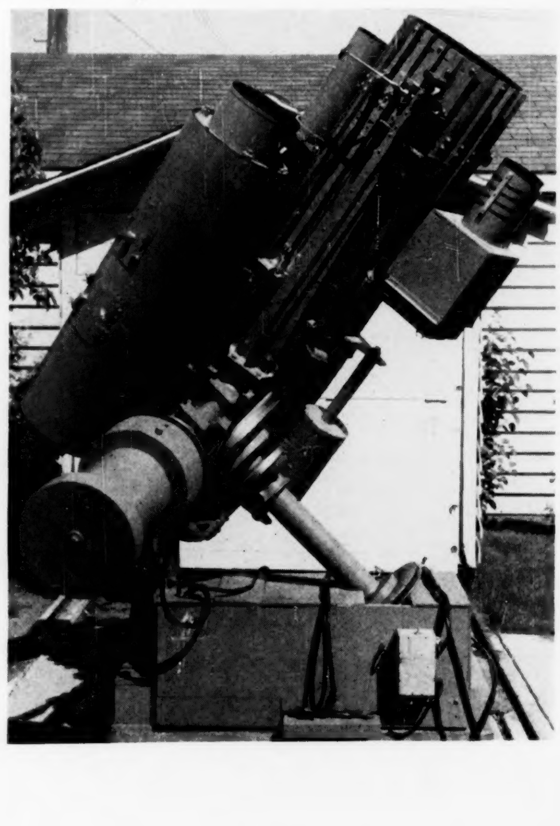
The deviation of the surface of a correcting plate from a plane, assuming that all of the correction is on one face, is given by the equation

$$\triangle x = \frac{y^4 - ky^2r^2}{4(n-1)R^3}.$$

Here **n** is the refractive index of the glass, **R** is the radius of curvature of the primary spherical mirror, **r** is the radius of the clear aperture of the correcting plate (3" in this case), and **y** is the distance along the radius, measured from the center of the plate to the point for which the deviation $\triangle$**x** is required. I have taken **k** = 1.0, which minimizes the amount of glass to be removed.

By expressing **R, y,** and **r** in inches, this the equation gives $\triangle$**x** in the same units and this is easily converted to fringes of sodium light, or light of any other chosen wave length. Using this formula, I constructed the graph on page 561, giving $\triangle$**x** (in fringes of sodium light) in terms of y. Since the correcting plate is symmetrical, only one half of the curve has been drawn.

The problem consists of working a curve into the plate such that its departure from a plane agrees with the curve in this diagram. To test the pro-



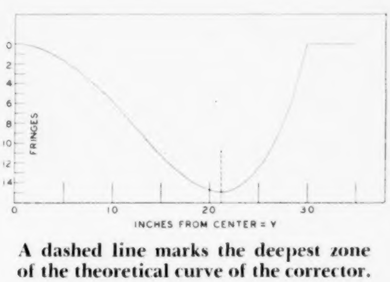
**Prof. Cooke's Schmidt camera (left) is on the same mounting with his 12½-inch f/4.6 Newtonian reflector (latticework tube), a 4¼-inch long-focus reflector, and an f/5 camera of 12-inch focus. The upper door in the Schmidt tube is for adjusting the filmholder, the lower for loading filmholders into the camera.**

**The faintly glowing filaments of the Veil nebula in Cygnus are recorded in this 65-minute exposure on Super XX film with the Schmidt camera described here.**

cedure, a piece of cheap plate glass was ground and polished plane, and a tool was made like that described by H. W. and L. A. Cox in *ATM—Book Three*. Instead of attaching the lead facets to the sponge rubber with gold size (our local product dried too slowly, and then showed a distressing tendency to release the facets), they were "pitched" on to the rubber with a soldering iron. Using No. 8 garnet fines, I worked the tool over the face of the plate with nearly diametral 1″ strokes. When the curve seemed deep enough, I made a polishing tool similar to that of Cox and Cox, and polishing was begun. At the end of one hour, the polish was excellent at 0.7r from the center, fairly good at the center itself, but quite poor at the edge.

A 6″ flat was set up in a testing unit like that described by R. E. English in *ATM—Book Three*. The flat was brilliantly illuminated by a Bunsen burner whose flame contained a piece of asbestos steeped in a saturated salt solution. The plate was placed face down on the flat, centered, and tilted with mild pressure until the interference pattern became a series of concentric rings symmetrical with respect to the center of the plate. Too much pressure is at once shown by distortion of the rings. After the glass had reached equilibrium with the radiated heat from the burner, a ruler was placed across the plate, and the diameter of each successive ring was measured. Because of the bright illumination, I could use a low-power telescope, thus avoiding errors caused by reading with the eye too close to the plate.

Upon plotting $\triangle x$ (in fringes, counted from the center) against y (the measured radius of the corresponding ring), it was found that in the case of this experimental plate the inversion of the curve came exactly at 0.707r from the center, and the smooth measured curve departed




**A dashed line marks the deepest zone of the theoretical curve of the corrector.**

from the theoretical one by only a fringe at most. This excellent agreement was of course largely luck. After another hour of polishing I tested the plate again. It was now about two fringes overcorrected, and the otherwise excellent polish was still very poor in the outer $\frac{1}{4}$″.

Several similar attempts were made on other plates to obtain a good polish to the very edge, but none was successful. The curves obtained by grinding were excellent, but efforts to force the polish at the edge inevitably spoiled the curve.

Therefore it was decided to *polish* the curve into the plate, starting with a polished plane surface, and omitting the grinding stage. A tool was constructed of pitch facets attached to lead facets cemented to a circular sponge-rubber pad $\frac{1}{2}$″ thick. This pad was attached with pitch to a 6″ glass disk of the same thickness. The pitch polishing surface was trimmed into petal-shaped areas, like those of Cox and Cox's grinding tool

The work was started with a plane plate-glass surface, face up. By machine, the tool was carried in $\frac{1}{2}$″ to 1″ strokes across the diameter of the glass. Testing was carried out after each 15-minute period of figuring. Very quickly an undercorrected Schmidt curve began to appear, deepening as figuring proceeded until the maximum depth of 15 fringes was obtained. Unfortunately, the deepest zone did not come at 0.707r but about $\frac{1}{4}$″ nearer the center. To correct this, I made another tool with the zone of maximum wear at 0.85r, and using this on another plate-glass plane I obtained a surface that departed no more than $\frac{1}{4}$ wave from the theoretical curve shown in the diagram.

With this same tool, figuring was commenced on the piece of glass originally intended for the correcting plate. When the work was completed, the zone of maximum departure from a plane came at 0.707r as closely as could be measured, and was 15 fringes deep. The deviation from the theoretical curve was estimated to be no more than $\frac{1}{2}$ fringe at any place. At the inversion point, the curve deepened steadily during working at a rate of one fringe per 15 minutes, so that the actual time spent in figuring was about four hours.

The pitch lap described above has the disadvantage that it is difficult, with the sponge rubber backing, to press to uniform contact. Also, trimming such small areas is awkward. An alternative method consists of cutting honeycomb foundation into the shape of the petals desired and attaching these to the sponge rubber. The petals can be tacked to the rubber by the judicious use of a soldering iron around the edges. Otherwise, a thin layer of beeswax can be melted on to the surface of the rubber with a soldering iron. If the petals are laid on the wax just before solidification occurs, they will become firmly cemented into place. While the honeycomb foundation does not give

as smooth a finish as pitch, the errors are very minute, and the expedient is fully justified by its simplicity.

The procedure I have described worked well for the relatively shallow curve required. Just how deep a curve can be satisfactorily made in this way is not known, but I would expect no particular difficulty in working twice as deep.

The finished camera, attached to a 12½-inch, f/4.6 Newtonian, is giving excellent service. Use of a small relative aperture for the Schmidt has been justified for my location, only a few miles from the lights of a large city. Severe fogging sets in after 45 to 60 minutes of exposure. After a two-hour exposure on nights of moderately good seeing, the faintest star images measure 20 microns in diameter, when Super XX panchromatic film is used.

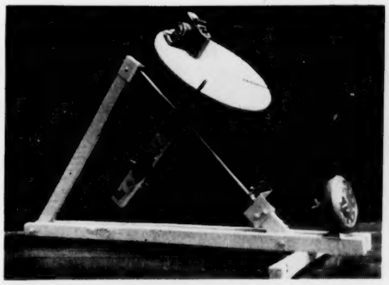
My drive was rebuilt for photographic work. It performs well, and to obtain circular images of the size stated the movement of the star image on the film must be less than two or three microns. The telescope is normally driven at the sidereal rate, and corrections are applied in right ascension through a motor-driven differential, and in declination through a reversible motor drive.

STRATHMORE R. B. COOKE
School of Mines and Metallurgy
University of Minnesota
Minneapolis 14, Minn.

### A SIMPLE MOUNTING FOR ASTRONOMICAL PHOTOGRAPHY

The accompanying photograph shows a clock-driven equatorial mounting for small cameras, constructed by John Stofan, 332 Herrick Ave., Teaneck, N. J., which is particularly well suited for meteor photography.

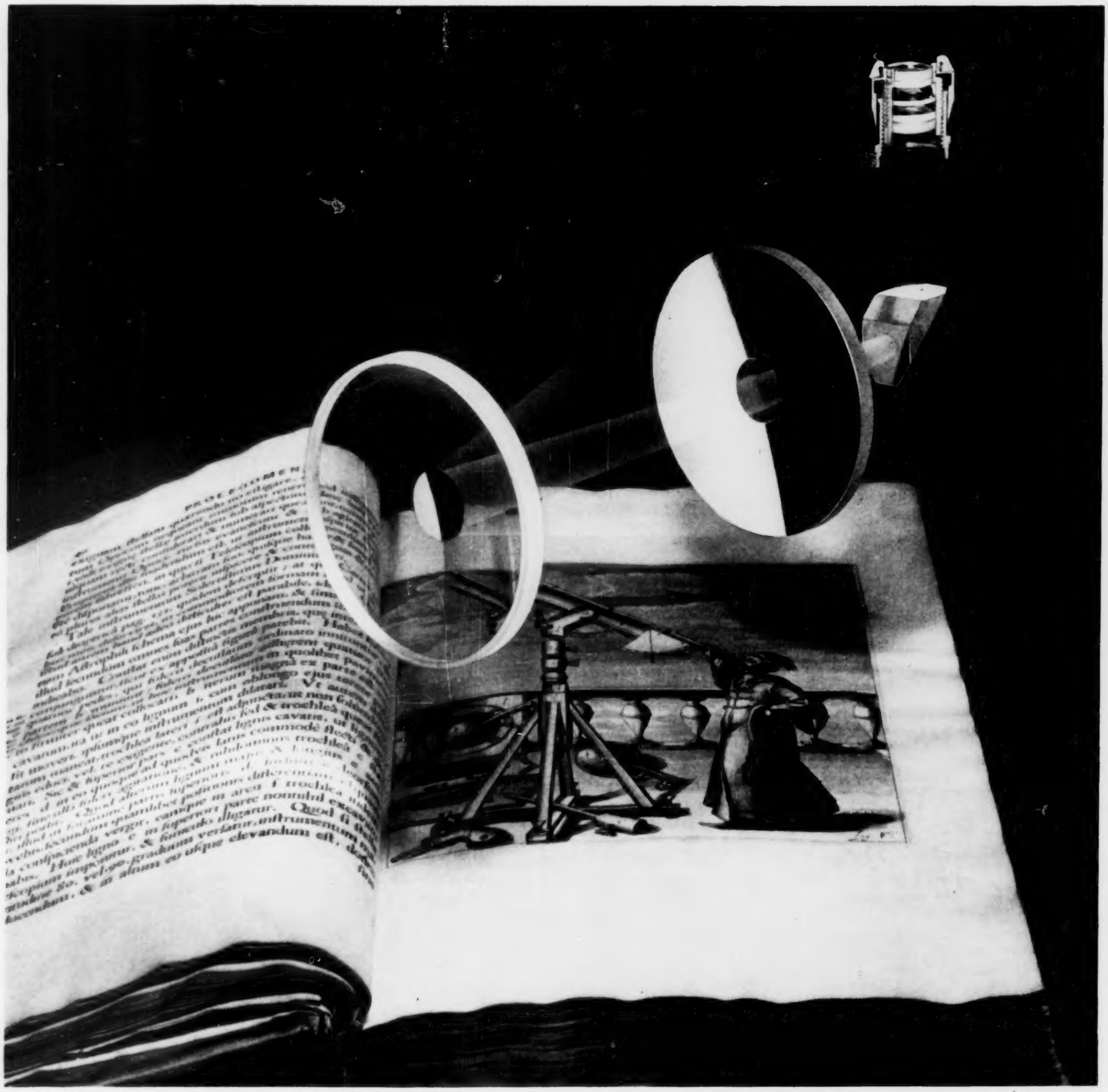
Secured to the base frame is an alarm clock, whose hand-setting button is connected by a flexible shaft to a six-leaf



piece of pinion wire. This engages a 144-tooth gear frictionally fitted to the ½" shaft that serves as a polar axle. The support for the upper pivot may be swung back, allowing the polar axle to be lifted out.

Because the drive is a frictional one, the camera can be turned to any desired right ascension. The declination is chosen by rotating the counterbalanced disk.

SAMUEL E. W. HAINES
Box 171, Englewood, N. J.



# BREAK-THROUGH IN OPTICAL SCIENCE

In only 44 years the twenty-first century will be upon us. Many who read these lines will surely be around to celebrate the end of the second millenium and welcome the beginning of the third.

By that time, of course, there will be many new kinds of telescopes, for it seems unlikely that this prime tool of science will ever again go two hundred years without change, as it did from the eighteenth to the twentieth centuries.

We should imagine that many optical systems of the future will be of the new catadioptric, or mixed lens-and-mirror type, like the one pictured above, which is Questar's. The great discovery that a lens and mirror together could produce a whole new class of superior instruments, including the Schmidt camera, was the major break-through in optical science of our century.

Questar has employed the new principles to produce a Cassegrain system of extreme shortness. See for yourself how compact it is. Yet at 160 diameters this arrangement performs like a telescope 7 feet long!

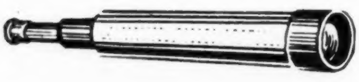
Notice how small we have kept the little secondary spot mirror — a secret of ultimate sharpness in Cassegrain design. Observe, too, that it has no diffraction-causing metal supports, being carried by the lens that seals off the tube against drafts, dirt, corrosion and insect attack.

Only 6 inches behind the 89-mm. aperture lens is the primary mirror of 97-mm. diameter. This is the jewel of exquisite surface, the part that for 3 years defied manufacture. For its f/2 focal ratio is so brutally short that its surface must be accurate to no less than 1/64 wave length in order to work at all. This is 16 times finer than the ¼-wave mirrors that suffice for conventional f/8 reflectors used by many veteran observers.

Having mastered the making of these elements to the new order of hyper-precision required, Questar offers the same optics in two styles of mountings — the elegant De Luxe Questar with ingenious built-in accessories, which is the most patented telescope of record, and the 31-ounce Field Model.

The happy astronomer at his small-apertured refractor appears in our copy of John Hevel's (Hevelius') ***Selenographia***, published in 1647, just 38 years after Galileo developed the first practical telescope. The picturesque old boy above serves to remind us that refractors do not look much different after 309 years, and that the earliest observers were able men who well understood the value of massive, shakeproof mountings for their long spyglasses.

# "GIANT" 3-inch TELESCOPE



**40 power**

**NEW! JUST OFF THE ASSEMBLY LINE!**

Never before has anything like this been offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle-sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image — it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

A PERFECT GUIDE TELESCOPE..........................Special Price **$57.50**

## Aluminum Telescope Tubing

| O.D. | I.D. | Price Per Ft. |
|---|---|---|
| 2¼" | 2⅛" | **$1.20** |
| 3⅜" | 3¼" | **1.75** |
| 4½" | 4⅜" | **2.75** |
| 5" | 4⅞" | **2.75** |

All tubing is shipped POSTPAID.

## Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

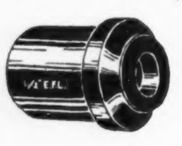
| | | |
|---|---|---|
| For 2⅛" I.D. Tubing | Postpaid | **$12.95** |
| For 3¼" I.D. Tubing | " | **12.95** |
| For 4⅜" I.D. Tubing | " | **12.95** |

Reflector type for all size tubing.
Complete with diagonal holder........**$ 9.95**

## Aluminum Lens Cells Black Anodized

| Cell for Lenses | Cell Fits Tubing | Price |
|---|---|---|
| 54 mm Diam. | 2⅛" I.D. | **$ 3.50** |
| 78 mm " | 3¼" " | **6.50** |
| 81 mm " | 3¼" " | **6.50** |
| 83 mm " | 3¼" " | **6.50** |
| 110 mm " | 4⅜" " | **10.50** |

## MOUNTED EYEPIECES

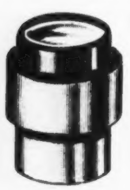


Each of these eyepieces is the buy of a lifetime at a terrific saving to you. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

| F.L. | TYPE | PRICE |
|---|---|---|
| 12.5 mm (½") | Symmetrical ........... | **$ 6.00** |
| 16 mm (⅝") | Erfle (wide angle)..... | **12.50** |
| 16 mm (⅝") | Triplet .................. | **12.50** |
| 18 mm (¾") | Symmetrical ........... | **6.00** |
| 22 mm (27/32") | Kellner .................. | **6.00** |
| 32 mm (1¼") | Orthoscopic ........... | **12.50** |
| 35 mm (1⅜") | Symmetrical ........... | **8.00** |
| 55 mm (2 3/16") | Kellner .................. | **6.00** |

The above eyepieces can be supplied **COATED** at 75 cents each extra.

## AN ECONOMICAL EYEPIECE



This mounted eyepiece has two perfect fluoride-coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x). The eyepiece cell fits a 1¼" tube................. **$4.50**

## "GIANT" WIDE-ANGLE EYEPIECE

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Same as above with coating.... **$32.00** Same as above with coating.... **$69.00**

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| Diameter | Focal Length | Each | Diameter | Focal Length | Each |
|---|---|---|---|---|---|
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| 54 mm (2⅛") | 762 mm (30")....... | **12.50** | 108 mm (4¼") | 914 mm (36")...... | **60.00** |
| 54 mm (2⅛") | 1016 mm (40")....... | **12.50** | 110 mm (4⅜")* | 1069 mm (42 1/16").... | **60.00** |
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# OBSERVER'S PAGE

**Universal time is used unless otherwise noted.**

## Safe and Sane Methods of Observing the Sun

SUNSPOTS are numerous these days, and they will probably be very abundant for the next several years. Therefore, telescope users will frequently want to turn their instruments to the sun, yet many may not realize the danger of damage to their eyesight from the intense solar glare, unless proper precautions are taken. The recommendations in this article combine the experience of Harry L. Bondy, director of the Solar Division of the AAVSO, and the writer.

**The projection method.** The safest way, also the simplest, and for the casual or inexperienced observer the best, is well known. It is to project the image of the sun through an eyepiece onto a white card or screen. The card and the eyepiece are adjusted until a good focus is obtained, and the image may be made of whatever size gives the best detail and scale. One of the advantages of this method is that several observers can look at the same time, and there is no danger involved. The telescope is easily pointed to the sun by means of its shadow on the screen or the ground.

If the card is mounted on a support attached to the telescope tube, a device supplied with many commercially built refractors, the image stays in focus and is well placed for examination. It is easy for reflector owners to build such screen supports for their instruments. Thus, the projection method is equally applicable to reflectors and refractors. If the observer's head and the screen are covered with a black cloth, in the manner of a portrait photographer, it is easier to study the details in the sunspots.

**The filter problem.** If, however, the observer desires to look directly at the sun, he is warned never to depend on a dark filter alone, either just in front of or in back of the eyepiece. For instance, older-type instruments, particularly refractors, sometimes are equipped only with sun filters which screw over the eye end of the eyepiece. These come in red, orange, green, and even blue shades, but they should never be relied upon alone. Such a filter may sooner or later crack in the concentrated solar rays, and the intense light coming through the crack can be enough to damage your eye permanently.

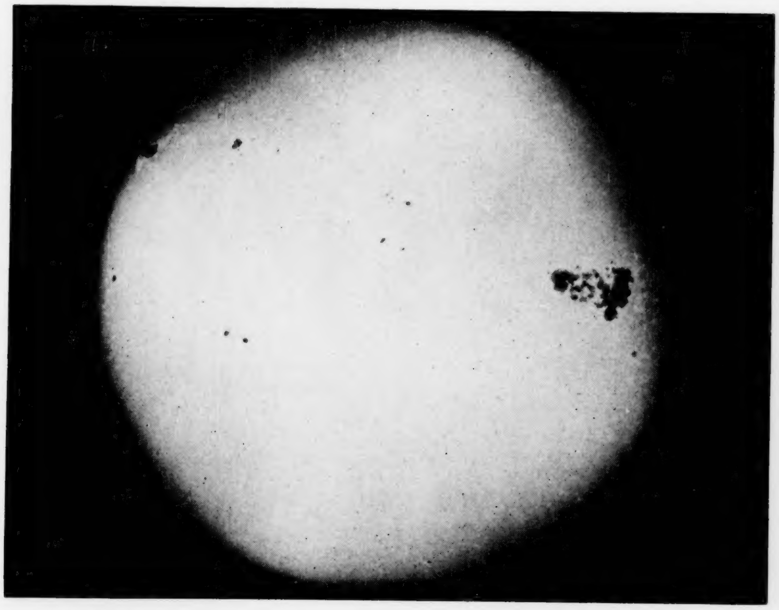
Therefore, the following *additional* precautions should be taken, either one or more of them:

1. Reduce the aperture of the telescope drastically with a diaphragm or pierced cap over the objective.

2. Use an uncoated mirror in a reflector.

3. Use a prism (not oriented for total reflection) in either a reflector or a refractor.

4. Use a Herschel wedge or some other device to provide *at least one reflection*



**On April 3, 1947, when the sun was near a maximum in its cycle of activity, the great group of sunspots at the right was being carried by solar rotation onto the visible face for the third time; thus the group was some two months old. Photograph by the Rev. William M. Kearons.**

**At the Stellafane convention in August (see pages 532-3) two methods of observing the sun were demonstrated. Left: Dr. Henry Paul (wearing a cap) has a polarizing monochromator attached to a refractor. Above: George Kantargas uses a medium filter in front of a Herschel wedge attached at the Newtonian focus of his reflector. Photographs by Robert E. Cox.**

*from unaluminized or unsilvered glass.*

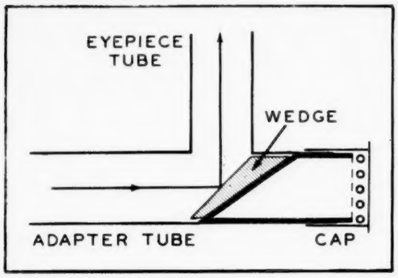
5. Use a partially transmitting metallic film in front of the objective, or crossed polaroids.

The following specific instances illustrate how the above suggestions may be put into practical use.

**Cutting down the aperture.** For a 6-inch reflector, a 2-inch off-axis diaphragm (cut from cardboard) should be placed at the front of the tube with the hole fully covered by a No. 12 welder's glass. Such a neutral filter can be purchased in 2-by-4-inch rectangles or in 2-inch disks (Willson Goggle Co., Reading, Pa., and others). There is little chance of this filter cracking since it is exposed only to normal sunlight. With this setup the observer can use his ordinary eyepieces, 40 to 70 power giving the best views of the sun.

Leaving the reflecting coating off the primary mirror cuts down its reflectivity about 95 per cent, and the aperture diaphragm can be four inches in diameter instead of two. A No. 10 welder's glass, $1\frac{1}{4}$ inches in diameter, can be placed in front of the regular eyepiece. Other eyepiece filters can be used if they are of the proper density.

**One reflection off unaluminized glass.** The classical method, and probably the best for looking at the sun with a refractor of 3-inch to 6-inch aperture, is to use a Herschel wedge or its equivalent. The wedge is constructed so that only the small part of sunlight that the front face reflects is sent out at right angles, the remainder being reflected by the back surface at a different angle or passing entirely through the wedge. The hypotenuse (front) face of a right-angle prism can also be used. In either case, however, five per cent of the concentrated solar rays are reflected toward the




**In the Herschel wedge, only one surface of the prism is effective in sending sunlight to the eyepiece. The cap protects the eyes and hands of unwary observers, and has ventilating holes to help dissipate the heat.**

eyepiece, and a welder's glass or other dense filter must still be used to protect the observer's eye.

In practice, the entire solar eyepiece is made up in one small, brass, right-angled assembly so it can be inserted in place of the usual eyepiece. But it should be noted that, to bring the telescope to a focus, the drawtube must be moved about 3 to $3\frac{1}{2}$ inches closer to the objective or mirror than for looking at the stars. Some refractors do not have this much focusing movement built in. In most reflectors, also, this long focusing movement is not available and, in fact, is not desirable for stellar work. If the telescope cannot be focused with such a wedge or prism in place, then this method cannot be used.

But a modification is possible in the case of reflectors, for a Herschel wedge can be substituted for the Newtonian diagonal, or provision can be made to reverse the right-angle diagonal prism when it is in use on the sun, having the light reflected from its uncoated hypotenuse face. In this case, the prism should be shaded or occulted to cut down the stray light that results when the sun's rays hit the prism directly upon first entering the telescope tube. This reversibility of the diagonal prism is not, however, easy to achieve mechanically.

**Other suggestions.** Penta prisms, which pass only $\frac{1}{4}$ per cent of the original light after two internal reflections, have possibilities both for reflectors and refractors, but the problem of focusing may be as troublesome here as it is with a Herschel wedge. Shading or blackening of some of the surfaces may be needed to cut down stray light.

Crossed pōlaroids alone will soon burn out if they receive the full light from the objective or mirror, but if used after one reflection off uncoated glass even a single polaroid, properly oriented, will produce pronounced dimming of the image of the sun. The writer recently tried out a piece of transparent plastic, covered with an evenly deposited thin aluminum film, as a full-sized filter in front of his objective, but this gave very poor definition. Some high-quality glass filters of this type are available with higher-priced commercially made telescopes. One company makes a solar device that consists of a thin glass filter thickly coated with chromium so it passes only a very small fraction of the sun's rays, but even this is provided with the usual welder's glass, just in front of the eyepiece.

**Eliminate the finder.** Do not allow anyone to look at the sun through the finder of your telescope. Whenever the writer has guests observing the sun, someone invariably gets the "bright" idea of looking through the finder. To avoid this, either cap the finder or remove it altogether, as it is not necessary for solar observing.

DAVID W. ROSEBRUGH
66 Maple Ave.
Meriden, Conn.

## MINIMA OF ALGOL

October 2, 17:35; 5, 14:23; 8, 11:12; 11, 8:01; 14, 4:50; 17, 1:38; 19, 22:27; 22, 19:16; 25, 16:05; 28, 12:53; 31, 9:42. November 3, 6:31; 6, 3:20; 9, 0:09.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.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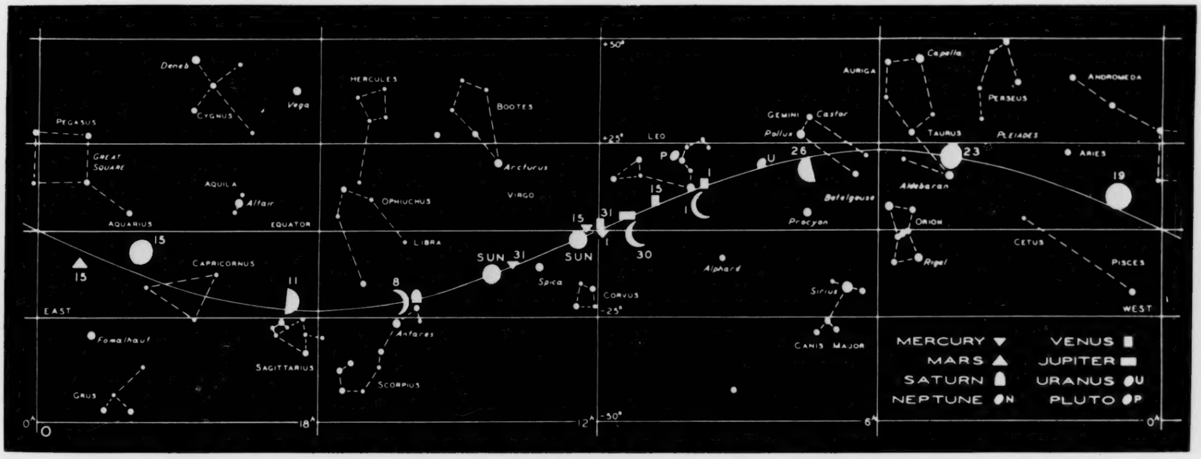


## THE SUN, MOON, AND PLANETS THIS MONTH

**The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown.**

**Mercury** will be better placed for morning viewing this month than at any other time in 1956. Greatest elongation occurs on October 12th, the planet being 18° 04′ west of the sun. At that time, Mercury rises $1\frac{1}{2}$ hours before sunrise, appearing at magnitude −0.3.

**Venus** may also be seen in the morning sky, rising $3\frac{1}{2}$ hours before the sun. The planet is still a brilliant object at magnitude −3.6 in midmonth. On October 5th Venus passes in its eastward motion half a degree south of the star Regulus in Leo. Another interesting conjunction occurs on the 25th, when the planet will be only 13′ north of Jupiter.

**Mars** remains a prominent object in the evening sky, having passed opposition last month. On the 12th Mars resumes its eastward motion among the stars of Aquarius. The red planet shines at magnitude −1.8 in mid-October, presenting a disk 19″.6 in diameter, closely matching its greatest size at the next opposition in 1958.

**Jupiter** rises about $2\frac{1}{2}$ hours before the sun in midmonth, a golden-yellow object of magnitude −1.3. Moving eastward, it is now near the boundary between the constellations Leo and Virgo.

**Saturn** can now be seen only low in the southwestern sky soon after sunset, a little west of Beta Scorpii. Its magnitude is currently +0.8. The ring system continues to open out, being tilted at 24°.8 to the line of view on October 15th.

**Uranus,** which comes to western quadrature with the sun on the 30th, rises at midnight in the middle of October. At the month's end, Uranus is less than a degree south of the Praesepe cluster in Cancer.

**Neptune** passes conjunction with the sun on the 23rd, and therefore cannot be observed until December. E. O.

## MOON PHASES AND DISTANCE

| | |
|---|---|
| New moon | October 4, 4:24 |
| First quarter | October 11, 18:44 |
| Full moon | October 19, 17:24 |
| Last quarter | October 26, 18:02 |
| New moon | November 2, 16:43 |

| | October | Distance | Diameter |
|---|---|---|---|
| Perigee | 1, $2^h$ | 227,400 mi. | 32′ 39″ |
| Apogee | 12, $23^h$ | 251,300 mi. | 29′ 33″ |
| Perigee | 27, $6^h$ | 230,000 mi. | 32′ 17″ |
| | **November** | | |
| Apogee | 9, $19^h$ | 251,300 mi. | 29′ 33″ |

## PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

**Bamberga,** 324, 7.9. October 4, 2:49.6 +36-25; 14, 2:44.7 +37-54; 24, 2:36.6 +38-43. November 3, 2:26.5 +38-49; 13, 2:17.0 +38-11; 23, 2:10.0 +37-04.

**Davida,** 511, 9.0. October 14, 2:48.0 −8-15; 24, 2:40.9 −8-58. November 3, 2:32.9 −9-22; 13, 2:25.0 −9-24; 23, 2:17.9 −9-01. December 3, 2:12.6 −8-15.

**Kalliope,** 22, 9.3. October 14, 3:31.1 +9-40; 24, 3:24.2 +9-46. November 3, 3:15.3 +9-54; 13, 3:05.6 +10-06; 23, 2:56.0 +10-25. December 3, 2:47.7 +10-53.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for $0^h$ Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

## SUNSPOT NUMBERS

**July 1,** 154, 162; **2,** 147, 155; **3,** 113, 133; **4,** 133, 153; **5,** 142, 138; **6,** 151, 139; **7,** 151, 163; **8,** 152, 158; **9,** 140, 150; **10,** 154, 157; **11,** 176, 162; **12,** 166, 216; **13,** 169, 192; **14,** 143, 156; **15,** 138, 156; **16,** 115, 144; **17,** 73, 98; **18,** 68, 67; **19,** 58, 65; **20,** 70, 71; **21,** 75, 78; **22,** 80, 86; **23,** 73, 113; **24,** 73, 84; **25,** 82, 90; **26,** 85, 100; **27,** 82, 116; **28,** 105, 104; **29,** 107, 108; **30,** 127, 130; **31,** 123, 140. Means for July, 117.9 American; 128.5 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

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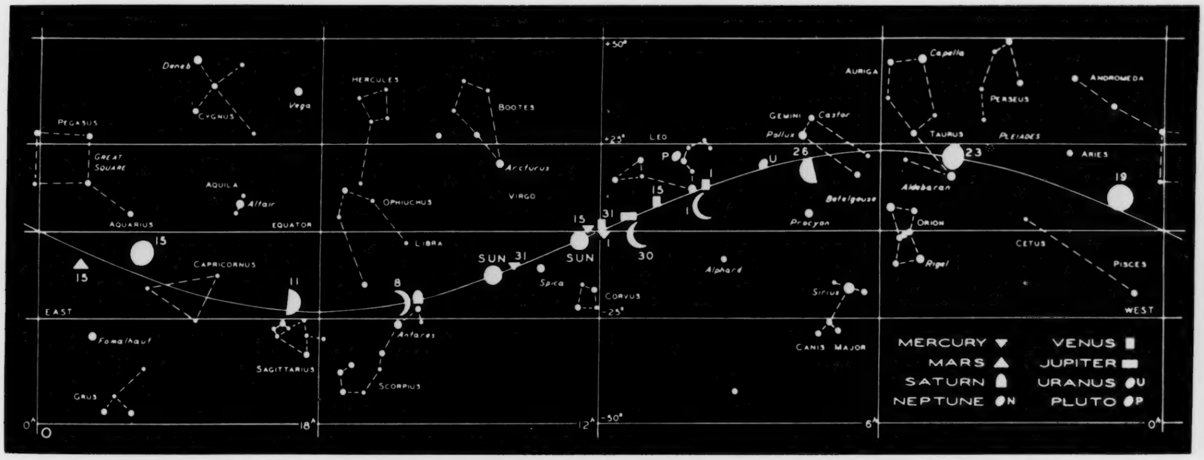


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## OCCULTATION PREDICTIONS

October 16-17 **Kappa Piscium** 4.9, 23:-24.7 +1-00.9, 13, Im: **A** 2:11.7 ....... 347; **C** 1:56.6 ....... 350.

October 23-24 **Chi¹ Orionis** 4.6, 5:51.8 +20-16.2, 20, Em: **A** 5:31.4 −0.6 +3.5 218; **B** 5:39.7 −0.8 +2.6 232; **C** 5:15.0 ....... 204; **D** 5:30.7 −0.6 +2.6 230; **E** 5:16.7 −0.2 +2.5 229; **F** 4:50.3 ....... 198; **I** 5:28.6 0.0 +1.0 284.

October 23-24 **Chi² Orionis** 4.7, 6:01.3 +20-08.5, 20, Em: **C** 10:50.8 ....... 219; **D** 10:52.4 −2.0 +0.7 239; **I** 9:45.4 −1.2 +1.7 251.

October 26-27 **Alpha Cancri** 4.3, 8:56.1 +12-01.8, 23, Im: **F** 8:36.7 −0.7 +1.3 82. Em: **F** 9:38.9 −1.2 −0.8 312; **H** 9:13.4 −0.7 −2.1 342.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**LO** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

| | | | | | |
|---|---|---|---|---|---|
| **A** | +72°.5, | +42°.5 | **E** | +91°.0, | +40°.0 |
| **B** | +73°.6, | +45°.5 | **F** | +98°.0, | +31°.0 |
| **C** | +77°.1, | +38°.9 | **G** | Discontinued | |
| **D** | +79°.4, | +43°.7 | **H** | +120°.0, | +36°.0 |
| | | | **I** | +123°.1, | +49°.5 |

## A MARTIAN OBSERVATION

On the morning of August 25, 1956, I was observing Mars with a 6-inch reflector, having 1/10-wave optics, at 375x through a red filter. Just after finishing a drawing of the planet, at 6:20 UT I saw a flash of white light on the eastern edge of the disk, lasting for about one second, and extending about three seconds of arc beyond the limb. After the flash there appeared here a white spot which protruded two seconds of arc outside the planet's edge.

At 6:30 UT the spot extended only 1½ seconds, and was rapidly becoming dimmer. Finally, by 6:50 it no longer protruded beyond the limb, and appeared as an almost invisible marking on the disk, about 2.7 seconds in diameter.

R. R. RICHARDSON, JR.
927 McKinley Blvd.
Alton, Ill.

ED. NOTE: A sketch sent by Mr. Richardson indicates that his reported flash occurred in or near Ausonia. The longitude of the Martian central meridian at 6:20 UT was 180°.

## DAYTIME VISIBILITY OF PLANETS

It is not often that we hear of planets other than Venus being visible to the unaided eye in broad daylight. But Jupiter and Mars can sometimes be thus seen, particularly when they are in conjunction with the moon, which makes them easier to locate.

The first time I saw Jupiter by day was on October 26, 1953, with the moon nearby. Jupiter could still be plainly seen more than an hour after sunrise. This was seven weeks before opposition.

Although Mars at favorable oppositions becomes about as bright as Jupiter, it is more difficult to see by day, possibly because of its color. This August 20th, when sky conditions were good, Mars could be seen for about a quarter of an hour after the sun had risen. I would like to hear from other amateurs who have tried this experiment.

FR. M. ADRIAN, O.C.S.O.
Trappist Fathers
North Rogersville
New Brunswick, Canada

## PERSEID OBERVATIONS

The annual Perseid meteor shower was unusually rich in 1956, according to early reports. At Hemmingford, Ontario, 16 members of the Royal Astronomical Society of Canada counted a total of 502 Perseids, almost entirely between 11:25 p.m. and 4:45 a.m., on the night of August 10-11. These observers agreed that it was the finest shower they had ever seen, with the exception of the memorable display of Giacobinids in 1946. Stuart O'Byrne, of Webster Groves, Mo., counted as many as 99 meteors per hour shortly before dawn on August 12th.

Twenty-three members of the Chicago Junior Astronomical Society and eight adults camped at Indiana Dunes state park on the nights of August 10-11 and 11-12, equipped with 13 telescopes, including a 10-inch reflector. During the Perseid meteor shower four observers counted a total of 105 meteors, according to Bernadette Londak, vice-president of the society.

### DEEP-SKY WONDERS

NOW, with the growing crispness of autumn evenings, the Milky Way slides away into the west. Before Orion dominates the sky, the amateur may want to take some last views of the clustered splendors of earlier months. A fine object in binoculars or rich-field telescopes is "Brocchi's cluster" at $19^h$ $23^m$, $+20°$, in Vulpecula, lying not far from the double star Albireo. It is visible to the naked eye in a dark lane of the Milky Way. Telescopically, it is an open group of 5th- to 10th-magnitude stars, about a degree in diameter, whose brighter members form a "coat hanger." Were it in Virgo or Hydra, away from its rich Milky Way surroundings, it would be a well-known object. As it is, almost all catalogues omit this fine group, though Collinder's 1931 list contains it.

On the very edge of Brocchi's cluster, owners of larger telescopes can locate the small galactic cluster NGC 6802, at $19^h$ $26^m.2$, $+20°$ $04'$ (1950). This mass of very faint stars is $5'$ in diameter.

Not too far away from this, but overshadowed by the great Dumbbell nebula, lies Messier 71, also known as NGC 6838, at $19^h$ $51^m.5$, $+18°$ $39'$ (1950), a globular cluster $6'$ across. Situated in the arrow shaft of Sagitta, it is easy to locate, and is worth more than slight inspection by amateur observers.

Higher in the sky is a medium-faint planetary nebula not previously mentioned in this column. This is NGC 6905, at $20^h$ $20^m.2$, $+91°$ $57'$ (1950), just over the border in Delphinus. Photographs show its size as about $44''$ by $37''$, and the visual observer can trace it to about the same extent, although at least a 10-inch telescope is needed to make out the 14th-magnitude central star. I would like postcard descriptions from readers who manage to locate this object.

Also in Delphinus is the globular cluster NGC 7006, whose 1950 co-ordinates are $20^h$ $59^m.1$, $+16°$ $00'$. This 10th-magnitude cluster is only $1'$ or $2'$ in diameter, and it affords an interesting contrast with the nearby great globular cluster M15, in Pegasus at $21^h$ $27^m.6$, $+11°$ $57'$ (1950), which can be seen with the naked eye.

The writer of this column maintains a card catalogue of observations of nebulae by amateurs. I would like to know which ones you have seen, with brief descriptions, notes on brightness and points of interest, and the kind and size of telescope used.

WALTER SCOTT HOUSTON
Rt. 3, Manhattan, Kans.

### COMING ELONGATIONS OF MERCURY AND VENUS

The inferior planets Mercury and Venus are usually most easily observed near their times of greatest eastern (evening) elongation and greatest western (morning) elongation. Approximate predictions extending to A.D. 2000 have been published by M. B. B. Heath in the January and March, 1956, issues of the *Journal* of the British Astronomical Association.

His results are repeated here for Mercury to the end of 1959, and for Venus until the erd of 1969. After the date of greatest elongation is given the planet's angular distance from the sun, whether it is east or west of the sun, and, in the case of Mercury, the stellar magnitude. For Venus, the magnitude at elongation is always $-4.0$ or $-4.1$.

MERCURY ELONGATIONS

| | | |
|---|---|---|
| Aug. 31, 1956 | 27°.2 E | +0.5 |
| Oct. 12, 1956 | 18.0 W | −0.3 |
| Dec. 25, 1956 | 19.9 E | −0.3 |
| Feb. 2, 1957 | 25.3 W | +0.2 |
| Apr. 15, 1957 | 19.7 E | +0.4 |
| June 1, 1957 | 24.5 W | +0.7 |
| Aug. 13, 1957 | 27.4 E | +0.5 |
| Sept. 25, 1957 | 17.9 W | −0.2 |
| Dec. 8, 1957 | 21.0 E | −0.2 |
| Jan. 16, 1958 | 23.8 W | +0.1 |
| Mar. 29, 1958 | 18.8 E | +0.2 |
| May 14, 1958 | 26.1 W | +0.7 |
| July 26, 1958 | 27.1 E | +0.6 |
| Sept. 9, 1958 | 18.0 W | 0.0 |
| Nov. 20, 1958 | 22.2 E | −0.1 |
| Dec. 29, 1958 | 22.4 W | −0.1 |
| Mar. 12, 1959 | 18.3 E | 0.0 |
| Apr. 26, 1959 | 27.2 W | +0.7 |
| July 8, 1959 | 26.2 E | +0.7 |
| Aug. 23, 1959 | 18.4 W | +0.1 |
| Nov. 3, 1959 | 23.6 E | 0.0 |
| Dec. 12, 1959 | 21.0 W | −0.2 |

VENUS ELONGATIONS

| | |
|---|---|
| Aug. 31, 1956 | 45°.9 W |
| Nov. 18, 1957 | 47.2 E |
| Apr. 8, 1958 | 46.4 W |
| June 23, 1959 | 45.4 E |
| Nov. 11, 1959 | 46.6 W |
| Jan. 29, 1961 | 46.9 E |
| June 20, 1961 | 45.8 W |
| Sept. 3, 1962 | 46.2 E |
| Jan. 23, 1963 | 47.0 W |
| Apr. 10, 1964 | 45.8 E |
| Aug. 29, 1964 | 45.9 W |
| Nov. 15, 1965 | 47.2 E |
| Apr. 6, 1966 | 46.4 W |
| June 20, 1967 | 45.4 E |
| Nov. 9, 1967 | 46.6 W |
| Jan. 26, 1969 | 47.0 E |
| June 17, 1969 | 45.8 W |

### VARIABLE STAR MAXIMA

October 10, RR Sagittarii, 194**929**, 6.6; 14, S Gruis, 221**948**, 7.8; 27, R Horologii, 025**050**, 6.0; 28, V Bootis, 142539, 7.9; 31, R Leonis, 094211, 5.9.

November 1, R Corvi, 121**418**, 7.6; 2, R Andromedae, 001838, 7.0; 2, R Hydrae, 132**422**, 4.6; 4, S Pictoris, 050**848**, 8.0; 9, RS Librae, 151**822**, 7.7.

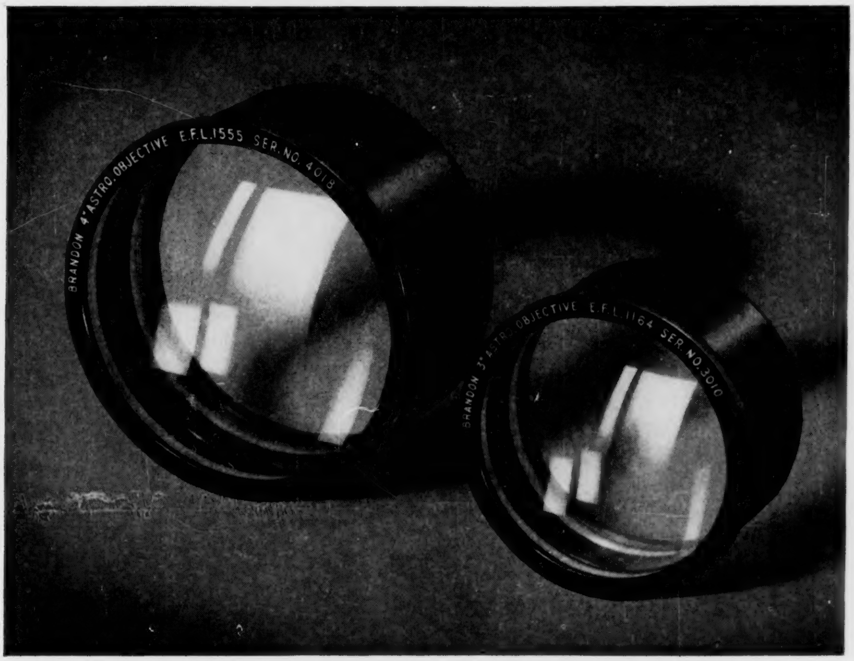
These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.


## STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of October, respectively; also at 7 p.m. and 6 p.m. on November 7th and 23rd. For other dates, add or subtract ½ hour per week.

Now high in the northeast, W-shaped Cassiopeia is conspicuous. Gamma in this group is variable; before 1936 it was about as bright as Alpha, and then increased until it briefly matched 1st-magnitude Deneb. Since 1940, it has been nearly as faint as Delta Cassiopeiae.

# Brandon Astronomical Objectives




*Each 4-inch and 3-inch Brandon objective is shipped already mounted in a cell, ready to attach to your own tube of aluminum, brass, steel, or plastic.*

## NOW ANY AMATEUR CAN MAKE HIS OWN REFRACTOR!

As every exacting telescope user knows, the heart of a telescope is its objective lens or primary mirror. It is difficult to make the four surfaces of an achromatic two-element lens, and few amateurs tackle the task. But the mounting of a mirror and the maintenance of a reflecting telescope are often costly and time-consuming, while a refractor can be constructed easily and inexpensively with one of our astronomical objectives. The finished instrument requires little attention over the years and is always worth its original cost.

Therefore, if you want to get the most telescope for your time and money, buy one of our first-quality objectives and mount it yourself simply by attaching the cell to a tube of the proper diameter and length. The other end of the tube should carry a smaller sliding tube which in turn has an eyepiece holder. Focusing may be done by sliding one tube in the other, by rack and pinion, or by a spiral-focusing mechanism.

You have no diagonal support problem, no diagonal or prism to shake loose, no complicated aligning, no diffraction patterns of diagonal and support. Even the five-foot tube assembly of a 4-inch refractor is light and easy to mount as an altazimuth or equatorial instrument (see *Amateur Telescope Making—Book Two,* pages 192-211). It can be put on a tripod that is easily portable or on a permanent pier. Refractors are noted for the ease with which they can be set up and taken down; they pack easily into boxes for shipment and travel. The refractor lens provides a large field of excellent definition suitable for all kinds of eyepieces and for direct or projection photography. Either of our objectives, combined with any of our seven eyepieces, gives a wide range of powers:

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|---|---|---|---|---|---|---|
| **3-inch f/15 lens:** | 290x | 195x | 145x | 95x | 75x | 50x |
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When atmospheric conditions permit, you can take advantage of the well-known resolving power of the refractor. You have the perfect instrument for observing details on the planets, such as Mars while it is still well located. Each Brandon lens is rigidly tested for its resolution of double stars before being sold. Brandon objectives enjoy an enviable reputation among professional and amateur astronomers for their fine performance. Check these features:

1. Superior optical design utilizing a larger air separation. Color corrected on C and F and hand corrected to reduce residuals to a minimum. Completely free of coma.
2. Glass-air surfaces magnesium-fluoride coated, increasing light transmission approximately 10 per cent.
3. Quality optical glass precision annealed and held to one ring test-plate match.
4. Cell made to precision tolerances and suitably coated to prevent stray light reflections. Each cell engraved with effective focal length and serial number.

These objectives are supplied with cells and rigidly tested on double stars for resolving power before being sold:

| | | |
|---|---|---|
| **3″ Clear Aperture** | **45.8″ Focal Length** | **$ 62.00** |
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**To make certain that your order reaches us promptly, be sure to send it and all correspondence by air mail (6 cents).**

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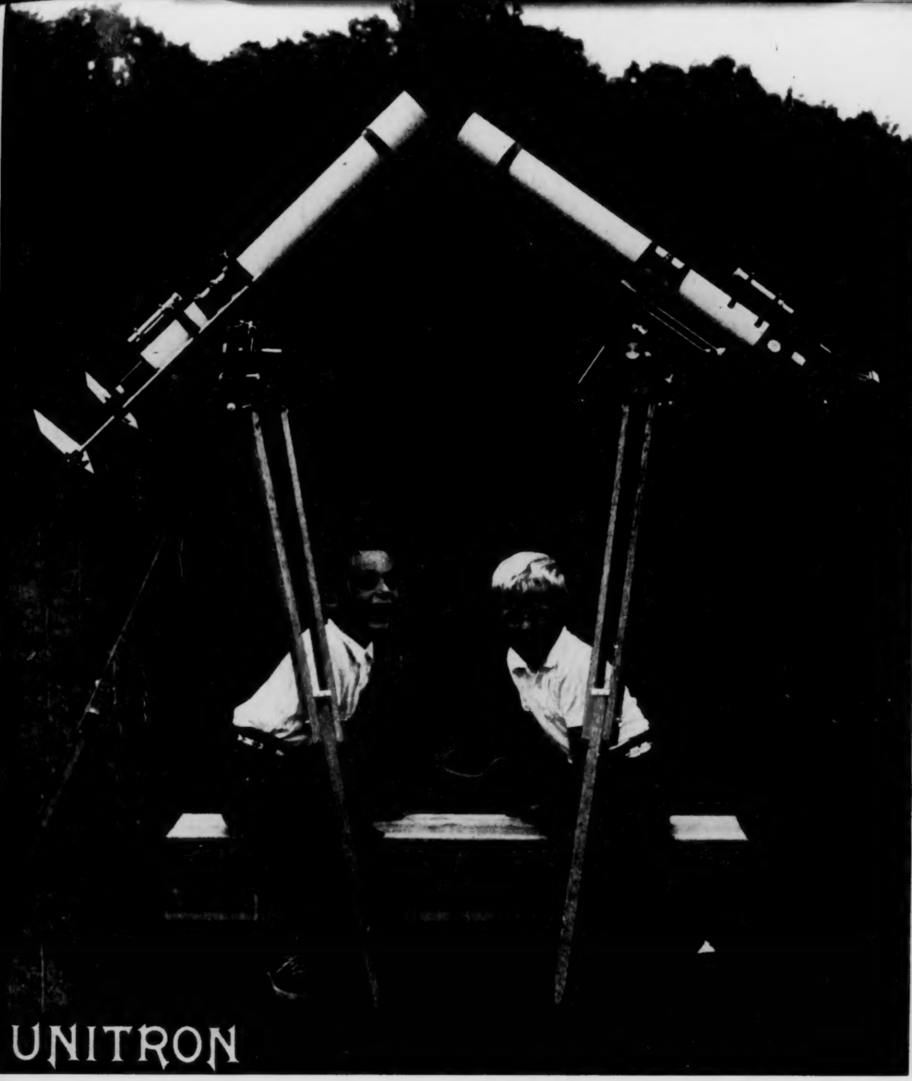
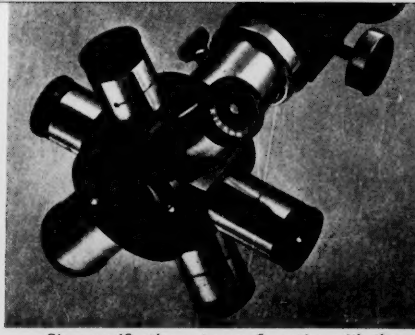
*Send self-addressed 6¢ (air mail) stamped envelope for other dimensions. Satisfaction guaranteed, or your money will be refunded.*

# Brandon Instruments

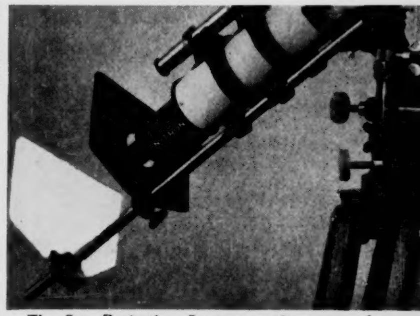
**GUAYNABO, PUERTO RICO**



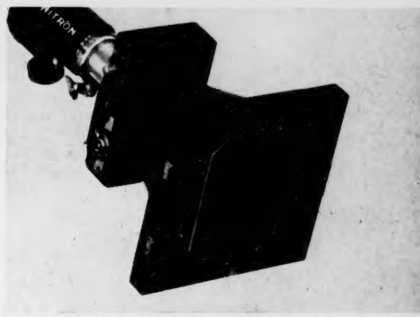



Six magnifications at your fingertips with the UNIHEX Rotary Eyepiece Selector.

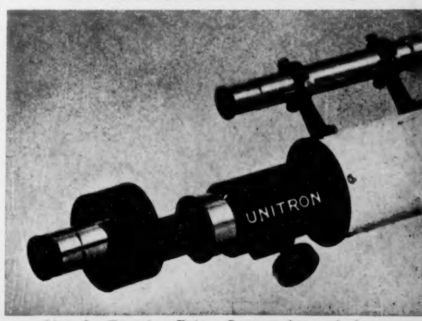
With the DUETRON Double Eyepiece, two observers may use the UNITRON together.



The Sun Projecting Screen permits group observation and accurate charting of sunspots.



With Astro-Camera 220, it's easy to photograph the sun, sunspots, the moon, and eclipses.




Use the Erecting Prism System for real closeup views of distant terrestrial objects.

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*See pages 550 and 551.*

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| Astro-Camera 220 with accessories | 69.50 |
| Erecting Prism System | 18.50 |
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